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THE BOTANICAL GAZETTE

EDITORS:

JOHN M. COULTER, University of Indiana, Bloomington, Ind.
CHARLES R. BARNES, University of Wisconsin, Madison, Wis.
J. C. ARTHUR, Purdue University, Lafayette, Ind.

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In the July number will appear:

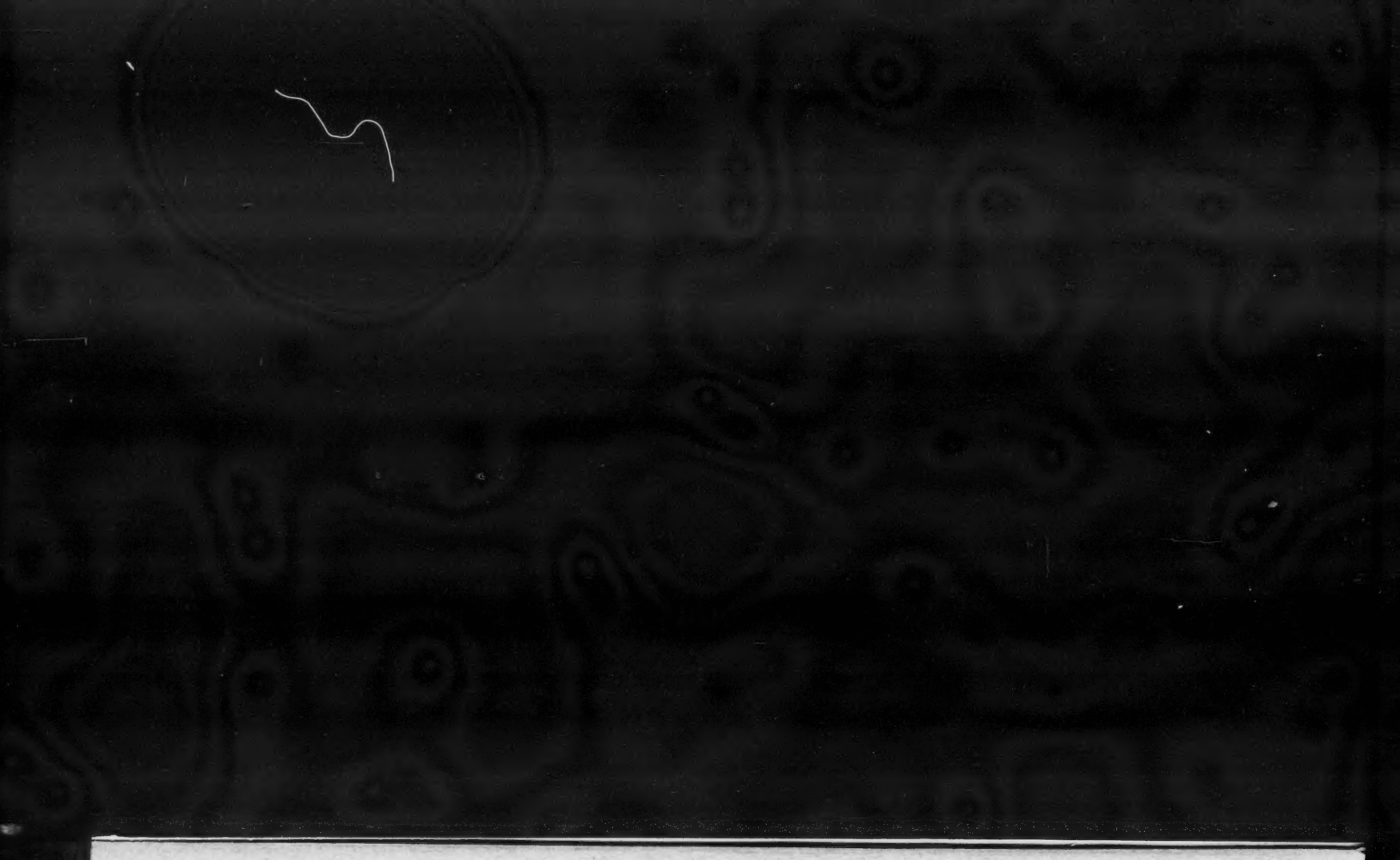
On the embryo-sac and embryo of Senecio aureus, by DAVID M. MOTTIER, *University of Indiana, Bloomington.*

Flowers and Insects. XI, by CHARLES ROBERTSON, *Carlinville, Ill.*

Descriptions of new species of Uredineæ and Ustilagineæ, by DR. P. DIETEL, *Leipzig, Germany.*

Contribution to the biology of the organism causing leguminous tubercles. *Third and concluding part.*

Mr. Mottier's paper, promised for June, was crowded out in spite of our increase to 48 pages.



CLIDEMIA CYMIFERA, Donnell Smith.

TYNANTHUS GUATEMALENSIS. Donnell Smith.

C. E. Faxon, del.

B. Meisel, lith. Boston

APHELANDRA HEYDEANA, n. sp.

BOTANICAL GAZETTE

JUNE, 1893.

Undescribed plants from Guatemala. XI.

JOHN DONNELL SMITH.

WITH PLATES XXI–XXIII.

This paper includes descriptions contributed by various botanists, who are kindly assisting in the elaboration of the plants of the series.

Capparis Heydeana (Subgen. CYNOPHALLA Eichl. in Fl. Brasil.)—Glabrate, axils eglandular: stipules minute; leaves obovate-oblong to elliptical-oblong ($4–5 \times 1\frac{1}{4}–1\frac{3}{4}$ in), acuminate, midrib excurrent, base acute, canaliculate petiole an inch or more long: flowers from axils of reduced leaves composing terminal short racemes; pedicels stout, exceeding petioles, apex incrassate: sepals oblong (8–10^{l}), obtuse: petals obovate-spatulate ($2\frac{1}{4}–2\frac{1}{2} \times \frac{3}{4}$ in): stamens scarcely as long, 6; carpophore equalling petals, ovary 2-locular: glands of disc distinct, triangular.—Remarkable in the genus by the large petals and in the sub-genus by the few stamens. Prof. Radlkofer, to whom this plant was submitted for comparison, calls attention to the accordance of its anatomical characters with those of *Cynophalla;* he observes the presence of soluble crystals in the cells of the upper and lower epidermis of the leaf such as occur in *C. Cynophallophorus* L., *C. polyantha*, Tr. et Planch. and other allied species (cf. Vesque in Ann. sc. nat. 6^{me} Sér. 103, t. xiii).—Tree 30–45^{ft} high, mountains overhanging Lake Ayarza, Depart. Jalapa, alt. 8,400^{ft}, Sept. 1892, Heyde & Lux, (ex Pl. Guatemal. qu. edid. J. D. S. 4,112).

Xylosma Quichense.—Arborescent (10–15^{ft}), unarmed, pubescent: leaves oblong-elliptical ($3\frac{1}{2}–5 \times 1–1\frac{1}{2}$ in), contracted-acuminate, base obtuse, upper surface shining and excepting nerves smooth, incurved-serrate, shortly petiolate: racemes solitary or 2–3-fasciculate, simple or paniculate, 3–6 times

exceeding petiole, scaly bracteose, 10–20-flowered, pedicels bracteolate above base, bracteoles linear-lanceolate (1–2^{l}): sepals 4–6, in anthesis broadly ovate, at length elliptical-oblong (2^{l}), glabrous, naked: glands obpyramidate, subconnate in a crenate cupuliform annulus: stamens numerous (20–35), not exceeding sepals: pistillate flowers and berries not seen.—*X. spiculiferum* Tr. et Planch., the only other species described with unisexual distinctly racemed and large-sepalous flowers, differs by spines, leaves ovate to orbicular-cordate, ciliate sepals, longer stamens, etc.—San Miguel Uspantán, Dept. Quiché, alt. 6,000^{ft}, Mch. 1892, Heyde & Lux (ex Pl. cit. 3,066).

Var. **subalpina**.—Glabrous excepting racemes, branchlets red and glandular-lenticellate: leaves ovate-elliptical, shorter, thicker: bracteoles colored, semi-sheathing, glandular-denticulate, subequalling pedicels.—Forests near El Jute, Depart. Quiché, alt. 10,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,064).

ARENARIA ALSINOIDES Willd., var. **ovatifolia.**—Leaves pilose, ovate-acuminate, base rounded or cuneate, subsessile: petals twice larger (5^{l}) than sepals: seeds numerous (18–30), punctulate, red.—Volcan de Agua, Dept. Zacatepequez, alt. 10,000^{ft}, June 1892, Dr. W. C. Shannon, U. S. A., (ex. Pl. cit. 3,635).

Stigmaphyllon cordatum Rose.—Climbing shrubs: leaves ovate to oval, 1½ to 3 inches long, deeply cordate at base with sinus open, rounded or with a short acumination, glabrous on both sides, minutely reticulated; petioles often elongated, biglandular at top: inflorescence a simple or compound umbel; peduncles 4 to 7 inches long; rays either wanting or sometimes 4 inches long; pedicels 6 to 12 lines long, bibracteate below the middle; calyx 5-lobed, 8-glandular: petals oval, obtuse with denticulate margins: fertile stamens 6; styles 3; stigmas with triangular dilation: samaræ generally 3, 15 lines long, oblong, obtuse, dorsal side toothed 2 or 3 lines above the base without lateral crests.—Depart. Guatemala, alt. 5,000^{ft}, Mch. 1892, Heyde & Lux, (ex Pl. cit. 3,267).

Oxalis clematodes.—Fruticose; branches long-reclinate, fuscous, pilose, extremities cano-villose: petioles incrassate-articulate at barbate axils, twice exceeding leaves: leaflets ternate, subsessile, obovate (6–11 × 4–7^{l}), emarginate or entire,

the lateral oblique, the terminal one somewhat larger, pilose, canescent beneath: peduncles filiform, chiefly twice exceeding petiole, cymes 2–5-flowered, pedicels not geniculate: sepals oblong, apex rounded: petals thrice longer (7'), obtuse, yellow: filaments connate above ovary, edentate, the larger ones scabrid: capsule cano-villose, cells uniovulate or occasionally two-ovulate.—The most nearly related species, *O. pentantha* Jacq., differs by a less shrubby habit, pinnately trifoliolate leaves, acute sepals, dentate filaments, 3–4-ovulate cells, etc.—San Miguel Uspantán, Depart. Quiché, alt. 6,500ft, April, 1892, Heyde & Lux, (ex. Pl. cit. 2,992.)

Wimmeria cyclocarpa Radlk.—Rami hornotini, pedicelli, petioli foliaque (subtus densius, supra sparsim) pubescentia; folia majuscula, petiolo 8mm adjecto circ. 7cm longa, 3cm et ultra lata, elliptico- vel ovato-lanceolata, acuta, vel abbreviata obtusa, immo suborbicularia, minutim glanduloso-serrulata, reti venarum pellucido laxiore instructa, pallide viridia; dichasia axillaria, quam folia breviora, 7–15-flora; fructus suborbicularis, vix brevior quam latus, diametro circ. 2cm, basi et apice excisus, alis membranaceis, styli brevis apice 3-stigmatosi reliquis coronatus, e roseo pallescens.—OBSERV. Intermedia quasi inter W. pubescentem Radlk. (in Sitzungsber. k. bayer. Acad. 1878, p. 378) et W. confusam Hemsl. (W. pallidam Radlk. l. c. p. 379) et quidem quoad characteres anatomicos quoque: W. pubescens hypodermate fere continuo ad paginam foliorum superiorem instructa est, W. cyclocarpa supra venas tantum, W. confusa nullo. Ab una alteraque differt cellulis crystallophoris crystalla singula magna, ut in W. discolore et concolore, nec globoso-agglomerata foventibus. Insignis quoque stomatibus quodammodo elevatis. Uti omnes Wimmeriæ species, quam rem 1885 observavi, excellit cellulis liberi quibusdam (et ramorum et foliorum) materia elastica fœtis, quæ materia *kautchouk* certe affinis est et illam *Parameriæ* a me olim (in Sitzungsber. k. bayer. Acad. 1884, p. 515) descriptam in mentem revocat. Similem materiam inveni in *Tiliacearum* (*Prockiearum*) genere monotypico "*Plagiopteron* Griff." (*P. suaveolens* Griff.—in tabula *P. fragrans* ab autore appellatum—nunc *Sapindaceis* nunc *Malpighiaceis* nunc *Euphorbiaceis* affine dictum, cf. Walp. Rep. v. 370, Kurz For. Fl. Brit. Burma i. 172), in cortice, corona medullari, foliis florisque partibus. Deest hæc materia in reliquis *Prockiearum* generibus "*Prockia*" et "*Hasseltia.*" Deest quoque in genere

quam maxime *Wimmeriæ* affini, sed Asiæ incola (ex Forbes et Hemsley in Jour. Linn. Soc. XXIII. 125 monotypico) quod Hooker filius "*Tripterygium*" nominavit (T. Wilfordii Hook. f.). In quibusdam vero a nonnullis inter *Celastrineas* adscitarum *Hippocrateaceæarum* stirpibus taliscumque materia obvia est, uti nuperrime D. Solereder observavit (ex. gr. in Salacia micrantha Peyr. et in truncis quibusdam a H. Schenck sub. n. 347[b], 519 et 632 missis, *Salaciæ* et *Hippocrateæ* generibus, ut videtur, adscribendis (quorum unus, n. 632, in Engl. & Prantl Pflanzenfam. a D. Niedenzu sub *Malpighiaceis*, Fig. 37 A et B, depictus est). Suo loco D. Solereder ipse hanc rem (nec a Th. Loesener sub *Hippocrateaceis* in Engl. & Prantl Pflanzenfam. 1892, nec a H. Schenck in Anat. Lian. II, 1893 indicatam) fusius traclabit. (L. Radlkofer.)—Tree 30[ft] high, slopes of the volcano Jumaytepeque, Depart. Santa Rosa, alt. 6,000[ft], Sept. 1892, Heyde & Lux (ex Pl. cit. 3,708).

RHAMNUS CAPREÆFOLIA Schlecht., var. **discolor**.—Leaves somewhat coriaceous, upper surface excepting veins glabrous, the lower cano-velutinous.—Coban, Dept. Alta Verapaz, alt. 4,300[ft], Aug. 1885, von Türckheim, (ex Pl. cit. 710); distributed as typical. No. 3,051 of the series is more true to the description.

THOUINIA ACUMINATA Watson, var. **pubicalyx** Radlk.—Calyx pilis adpressis dense cano-pubescens.—A tree 25–30[ft] high; mountains around Lake Ayarza, Dept. Jalapa, alt. 8,800[ft] Sept. 1892, Heyde & Lux, (ex Pl. cit. 3,955); Volcan Jumaytepeque, alt. 6,000[ft], Nov. 1892, Heyde & Lux (ex Pl. cit. 4,122).

HELODISCUS ARGENTEUS Maxmw. (*Spiræa argentea* Mutis), var. ? **bifrons** Focke.—The genus *Helodiscus* is distinguished from *Spiræa* by its indehiscent carpels. This important character is associated with a peculiar habit, and it will therefore be advisable to keep the two genera separate. The North American *H. discolor* Maxmw. (*Spiræa discolor* Pursh, *Sp. ariæfolia* Sm.) is a very variable plant, and its subspecies *dumosa* Wats. looks like a different species approaching the *H. argenteus* by its narrow leaves. In the typical *H. argenteus* the leaves are silky above, but very likely this character is not constant. In our plant, as in other Guatemala specimens that I have seen, the upper surface of the leaves is glabrous (var. *bifrons*). It has larger flowers than

H. discolor, and narrow cuneate leaves tapering into the short stalk. After all it seems to be more natural to put it under *H. argenteus* than under *H. discolor;* but it may be doubted if true limits exist between these two pretended species. The specimen n. 3,034 is a very large one, and was gathered from a bush 3–4 yards high. The plant represented in H. B. K. Nov. gen. Amer. VI. tab. 562, as well as Guatemala specimens in the Berlin Herbarium, are very much smaller. (W. O. Focke).—Nebáj, Depart. Quiché, alt. 7,000ft, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,034).

RUBUS TRILOBUS Moç. et Sessé, var. **Guatemalensis** Focke.—Branches, petioles and under surfaces of the young leaves slightly pubescent, not so hairy as in the typical plant. Leaves broader than in type, slightly three-lobed; base of the terminal lobe often broader than its length, the lateral ones very short or indistinct.—Volcan de Agua, alt. 8,000ft, June 1892, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 3,631).

Rubus superbus Focke.—Rami suppetunt duo florentes.—Rami cum petiolis tomentoso-pubescentes, sparsim et minute aculeati. Stipulæ petiolares parvæ filiformes. Folia ternata, foliola omnia petiolulata, subcoriacea, crebre et argute serrata, utrinque in nervis pilosa, ceterum glabriuscula, supra nitida, subtus opaca; foliolum terminale ellipticum, longe acuminatum, basi rotundatum, in utroque latere 8–10-nervia; lateralia paullo minora similia. Inflorescentia sat ampla, elongata, inferne folio uno ternato et altero simplici prædita, subracemosa vel ramulis inferioribus trifloris paniculata. Rhachis cum pedunculis tomentoso-hirsuta, minute aculeata; bracteæ lanceolatæ, parvæ, tomentosæ. Pedicelli sepalis multo longiores, laterales in ramulis trifloris approximati, sed non oppositi. Flores spectabiles; sepala ovata, concava, utrinque cano-tomentosa. Petala magna, obovata, unguiculata, sepalis duplo vel triplo longiores. Stamina numerosa, stylos superantia, post anthesin patentia. Carpophorum hirsutum; carpella numerosa, styli apice clavati stigmate magno coronati.—The specimens were gathered in an old cornfield, and their growth may therefore have been more luxuriant than it would have been in other places. The size of the flowers is much greater than in any of the allied species, their diameter in a dried state being about one and one-half inches. Notwithstanding the imperfect knowledge of the plant there can be no doubt that it is sufficiently distinct from all described

species. Among the brambles (*Eubatus*) of Mexico and Central America *R. fagifolius*, *R. scandens*, *R. Schiedeanus* and *R. coriifolius* bear their flowers in compound racemes; *R. adenotrichos*, *R. Bogotensis* and allied forms are distinguished by their copious glandular bristles; *R. sapidus* may be easily distinguished by its short racemose inflorescence and prickly peduncles; in *R. humistratus* the flowers are usually solitary; *R. floribundus* has soft tomentose leaves; *R. Liebmannii*, *R. tiliæfolius* and *R. Uhdeanus* have small flowers and very hairy leaves. (W. O. Focke.)—San Miguel Uspantán, alt. 6,000ft, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,326).

Rubus poliophyllus Focke.—(*R. coriifolius* Focke in Enumer. Pl. Guatemal. qu. edid. J. D. S. Part. II. p. 19; non Liebm.)—Rami teretiusculi, tomentoso-puberuli, aculeis e basi lata compressa recurvis armati, florentes et terminales et laterales. Folia inferiora quinata vel subquinata, superiora ternata, suprema sæpe simplicia; stipulæ petiolares, parvæ, filiformes. Foliola omnia petiolulata, subcoriacea, mollia, argute serrulata, superne stellulato-tomentella, subtus canotomentosa, in utroque latere 8–10-nervia; terminale ovato-ellipticum vel oblongum, breviter acuminatum, lateralia minora similia. Inflorescentia mediocris, multiflora, divaricata, paniculata; rhachis ramuli pedicellique cano tomentosi, aculeis parvis raris setisque glanduliferis sparsis longis interdum quoque brevibus intermixtis muniti. Ramuli inferiores axillares, erecto-patentes, racemoso-pluriflori, sequentes bracteolis trifidis tomentosis suffulti, patentes, supra medium 3–7-flori, supremi bracteis simplicibus lanceolatis muniti, approximati, vulgo uniflori, florem terminalem superantes. Sepala ovata, breviter mucronata, utrinque tomentosa, post anthesin patentia. Petala (mediocria vel parva?), decidua, alba. Stamina numerosa, stylis, ut videtur, æquilonga. Carpophorum pilosum; carpella sat numerosa, glabra. Fructus hemisphærici, nigri, ex acinis ca. 20 compositi.—This is the same species that I supposed at first sight to be a variety of *R. coriifolius*. Having seen more specimens I have no doubt now that it is quite different; in *R. coriifolius* all the branchlets of the panicle bear their flowers in racemes and not in cymes. It is much more difficult to distinguish the new plant from *R. Liebmannii* and *R. Uhdeanus;* its leaves, however, are much more tomentose than in the allied species. *R. Liebmannii* has a short drooping panicle and pink petals, *R. Uhdeanus* a

narrow elongated inflorescence and oblong fruits with very numerous grains. The leaves of *R. poliophyllus* resemble those of *R. floribundus* H. B. K., which has, however, a dense panicle, short pedicels and no glandular bristles. The knowledge of all these species is imperfect, and they require a more careful examination in their natural stations. As far as we can judge from the dried branches, it would be quite unnatural to put them under the same specific name. The specimens of this plant are nearly all alike; in no. 2,535 the pedicels bear besides the scattered long glandular bristles a quantity of short-pedicelled glands. In the Berlin Herbarium I have seen a specimen of this plant from Mexico (Otlamaltatle, Depart. Zacualtip, Prov. Hidalgo; leg. Seler sub no. 879). (W. O. Focke.)—San Rafael, Depart. Zacatepequez, alt. 6,500ft, April 1890, J. D. S., (ex Pl. cit. 2,141); same locality, Febr. 1892, J. D. S., (ex Pl. cit. 2,533); Volcan de Fuego, alt. 5,500ft, March 1892, J. D. S., (ex Pl. cit. 2,535).

CLIDEMIA CYMIFERA Donnell Smith, Botan. Gaz. XIV. 25: Cogn. in DC. Mon. Phan. VII. 1,017.

EXPLANATION OF PLATE XXI.—Fig. 1, flowering branch. Fig. 2, unopened flower. Fig. 3, petal. Fig. 4, vertical section of flower with petals removed. (Fig. 1 is natural size; the others are variously magnified.)

CUPHEA UTRICULOSA Kœhne, var. **Donnell-Smithii** Kœhne.—Differt a var. *α* et *β* foliis angustis, in ramis sterilibus linearibus, in fertilibus lineari-lanceolatis, præcipue vero calyce intus infra stamina in nervis omnibus villosiusculo. Flores ceterum ut in var. *α*; rami ut in var. Panamensi Hemsl. vestiti; fructus calycem æquans, quare stylus brevis totus exsertus.—Primavera, Depart. Sololá, alt. 800ft, July 1891, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 403).

Mallostoma Shannoni.—Cespitose: stems prostrate, rooting at nodes, tetragonal: ovate stipules 3-setose or the lateral bristles replaced by glandular teeth, short flat petioles decurrent in a pubescent wing, leaves oval to elliptical-oblong ($2\frac{1}{2}$–4×1–2^{in}), conterminously obtuse or acute, coriaceous, venation obscure, like stems rubro-punctate, revolute margin and midrib beneath pubescent: flowers terminal, solitary, 4-merous, 5^{l} long: calyx-lobes triangular-lanceolate (1^{l}), equalling turbinate tube and ebracteate peduncle, truncate sinuses glandular-denticulate: lobes of infundibuliform corolla somewhat shorter than tube, ovate-oblong, scaly-pubescent within, throat naked: filaments short ($\frac{1}{2}^{l}$): style a third shorter than

tube, large stigma subglobose: capsule obovate (2'), more or less free at apex, 8-costate, loculicidal at apex, septicidal at base; seeds 8–20, compressed, roundish ($\frac{1}{8}$'), finely punctate, black and shining.—Nearest to *M. setosa* Benth. et Hook., and especially to the form or var. (*Arcytophyllum setosum* Schlecht. in Linnæa, XXVIII, 489).—"Forming a carpet-like turf," Chichoy, Depart. Chimaltenango, alt. 9,000ft, March 1892, W. C. Shannon, Asst. Surg. U. S. A., associate of the Intercontinental Railway Commission, whose interesting collections along the lines of the surveys have been turned over to me for determination and distribution by Capt. M. M. Macomb, U. S. A., Engineer in charge, (ex Pl. cit. 371); San Miguel Uspantán, alt. 7,500ft, April 1892, Heyde & Lux, (ex Pl. cit. 3,176).

Hoffmannia rotata.—Stems above obtusely tetragonal and ferruginous-furfuraceous: leaves opposite or 3–4-verticellate, elliptical-lanceolate or oblanceolate (4–7×1–1$\frac{1}{2}$'), acuminate, more or less long-attenuated to short petiole, smooth above, paler and puberulous beneath with furfuraceous nerves: peduncles single in upper axils or pluri-fasciculate at lower nodes, filiform ($\frac{3}{4}$–2'), cymes 6–15-flowered, axes slender: calyx urceolate (1'), shorter than pedicel, teeth obtuse, sinuses glandular-appendaged: corolla rotate (4–5' in diam.), tube very short ($\frac{1}{2}$'), lobes oblong: filaments a half or two thirds as long as anthers: ovary 2-celled, connate-lobed stigma subequalling anthers: berry globose (2$\frac{1}{2}$'), crowned with incrassate limb, seeds red.—*H. pedunculata* Swz., related by foliage and corolla, is distinguished by merely opposite leaves, solitary peduncles, subsessile anthers, oblong berries and black seed.—A bush 3–6ft high; damp forests near San Migual Uspantán, alt. 7,000ft, April 1892, Heyde & Lux, (ex Pl. cit. 3,169 and 3,174).

Guettarda macrosperma (§ MATTHIOLA Benth. et Hook.)—Arborescent, younger parts flavo-sericeous: stipules round-ovate (2'), filiform-caudate, the interior toward base appendaged with intermixed subulate glands and white hairs: leaves ovate (2$\frac{3}{4}$ × 1$\frac{1}{2}$'), the younger rhomboid or obovate, sparsely pilose above, glabrate beneath except venation and with the the 6–7 costal nerves and transverse veins conspicuous: peduncles shorter than leaves (8–16'), velvety; flowers of twice bifid cymes crowded, 5–6-merous: calyx velvety, shortly tubu-

lar ($1\frac{1}{2}^{l}$), exceeding linear bract, thrice surpassing ovary, truncate: tube of sericeous corolla four times longer, thrice exceeding oval lobes: anthers narrowly linear ($1\frac{1}{2}^{l}$): style glabrous: drupe obovoid-oblong ($6–7 \times 3–4^{l}$), thick put amen angulate, 3–4-celled.—Santa Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, (ex Pl. cit. 3,160).

Parathesis calophylla.—Except upper face of foliage everywhere densely ochraceous-tomentulose: leaves elliptical-lanceolate ($6–8 \times 2–2\frac{1}{4}^{in}$), conterminously attenuate, tapering into canaliculate long (15×18^{l}) petiole, 15–20 costal nerves uniting within the revolute margins, evenulose, nigro-punctate beneath the tomentum: panicles chiefly axillary, subequalling leaves, broadly pyramidate, loose, axes stout and spreading; flowers exceeding pedicels, few-fasciculate at apex of secondary or tertiary branches: calyx-segments elongate-triangular (1^{l}): the corolline narrowly linear ($3\frac{1}{2} \times \frac{3}{4}^{l}$), albo-lepidote within: anthers nearly equalling filament ($1\frac{1}{4}^{l}$), obtuse, affixed at base, dehiscing throughout: ovary tomentose, tapering into style: berry not seen.—Other species with distinctly compound panicles may be distinguished either by glabrity or by minute calyx.—Tree 40–50^{ft} high with a slender trunk, the glossy upper surface of the leaves remaining green in exsiccate specimens, and contrasting elegantly with the dark-brown undersurface.—San Miguel Uspantán, alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 2,909).

PARATHESIS MICRANTHERA.—In describing this species, vol. XIV. p. 27, and likewise in its subsequent notice, vol. XVIII. p. 4, the specific name was inadvertently written *micrantha* instead of *micranthera*.

Ardisia venosa Masters.—Arbuscula, foliis crassiusculis ellipticis vel obovato-oblongis integris, basi in petiolum latum brevem angustatis, apice breviter abrupteque acuminatis, nervo medio superne sulcato subtus prominente, venis numerosissimis confertis reticulatim divisis, versus marginem arcuatis; cymis paniculatis pyramidatis amplis laxe ramosis, ramis patentibus, (cum pedicellis fasciculatim dispositis), pilis glandulosis dense obsitis; calycis breviter tubulati sepalis ovato-lanceolatis purpureo-maculatis; corollæ 4^{mm} long. tubo subventricoso, petalis æstivatione contortis oblongis acutis sepalis duplo longioribus; filamentis versus basin tubi inter tuberculos parvos emergentibus petalis dimidio brevioribus;

antheris flavis demum basi cordato-bilobis, apice lónge apiculatis, pollinis cellulis sphæricis; stylo corollam æquante vel superante.—Folia 20–25^{cm} long., 7–8^{cm} lat. Petiolus 2^{cm}. "Arbuscula gracilis 12–15 ped. fl. rubris albo-marginatis flavo-ocellatis."—Eastern slopes of Volcan Acatenango, Depart. Zacatepequez, alt. 7,000^{ft}, March, 1892, J. D. S., (ex Pl. cit. 2,485); Santa Rosa, alt. 4,000^{ft}, March, 1892, Heyde & Lux, (ex Pl. cit. 3,021).

Tabernæmontana arborea Rose.—A symmetrical tree, twenty-five feet high with trunk twelve feet long: leaves oblong to oblanceolate, three to eight inches long, abruptly acute or acuminate, tapering at base into a petiole (four to six lines long), shining above, paler beneath: flowers white, abundant in large compound corymbs: pedicels three to five lines long; bracts at base of flower none: calyx small; sepals oblong, obtuse one and one-half lines long: spreading scales four to five in the axil of each sepal: corolla tube slender, two to three lines long, narrower above, pubescent near the mouth; lobes oblong obtuse, five to six lines long: stamens inserted low in the tube, included: disk none; style short: follicles two, reflexed, compressed, oval, obtuse, two inches long, papillose-roughened.—The fruit in this species is much like *T. Donnell-Smithii*, but in habit, inflorescence, color and size of corolla, etc., the plant is very different. This species is not a typical *Tabernæmontana* but would belong to the genus *Peschiera* as the tribes were arranged by Miers. This latter genus, however, is not considered a valid one by Hemsley, nor by Durand. It differs from *Tabernæmontana*, as Miers defines it, in the shape of the corolla tube, the attachment of the stamens, the length of the style, absence of disk, papillose follicles and distinct ovaries—characters which it has in common with *Peschiera*, and which, if they be constant, ought to constitute a good genus. (J. N. Rose.)—Banks of the Rio Ocosito, Depart. Quezaltenango, alt. 250^{ft}, April, 1892, J. D. S., (ex Pl. cit. 2,766).

Tabernæmontana Donnell-Smithii Rose.—Large shrub 10 to 20 feet high, glabrous: leaves 3 to 8 inches long, 1 to 1½ inches broad, thin, oblong, tapering at base, abruptly long-acuminate, glabrous, entire, sessile or short-petioled: cymes with a few large flowers: bracts at base of flowers 3, broad and obtuse: calyx 5-parted; the two outer ones much shorter; the inner ones 8 lines long, 5 lines broad, obtuse, scales in

the axil of the sepals numerous: corolla yellow with broad obtuse lobes; tube 12 to 14 lines long a little swollen at the top: stamens inserted near the middle of the tube: disk prominent; style long; follicles 2, reflex, oblong and obtuse, $1\frac{1}{2}$ to 2 inches long by 1 to $1\frac{1}{2}$ inches broad; seeds numerous, oblong, 4 to 5 lines long.—Near *T. grandiflora*, but the follicles of this latter species are acuminate, the leaves evergreen, and the bracts and sepals different. Capt. Smith observes of this plant: "It is not exactly a tree in habit. It occurred everywhere I went from the coast up to the slopes of the volcanoes at an elevation of 5,000ft. The natives call it *cobal* (varnish gum)." *T. grandiflora*, as is known, was referred by Miers to *Stemmadenia*, but is retained by Mr. Hemsley in *Tabernæmontana*. The difference between these two genera is sometimes a little difficult to determine. My species has certainly the salver-form corolla of *Tabernæmontana*. (J. N. Rose.)—Under the following numbers of the series, collected by J. D. S., Depart. Escuintla, Escuintla, alt. 1,100ft, March 1890 (2,404), San Juan Mixtan, alt. 500ft, April 1890 (2,405), Naranjo, alt. 300ft, March 1892 (2,764), San José, sea-level, April 1892 (2,765); Depart. Amatitlan, Barranca de Eminencia, alt. 1,400ft, Feb. 1892 (2,762); Depart. Retalhuleu, San Felipe, alt. 2,000ft, April 1892 (2,763). Collected also by Dr. W. C. Shannon, U. S. A., Depart. Sololá, Primavera, alt. 1,400ft, Aug. 1891 (120), Santa Barbara, alt. 800ft, Aug. 1891 (152); Depart. Suchitepequez, Las Animas, alt. 600ft, Sept. 1891 (155).

Philibertia refracta.—Pubescent: stems branching: leaves ovate-lanceolate (24–28 × 10–12'), tapering to acute apex, base cordate, under surface except veins nitid, petioles a third as long: peduncles equalling leaves; pedicels filiform, half as long, 18–22-fasciculate, hirsute, exterior bracts linear-lanceolate and foliaceous: calyx-segments narrow, acute, hairy: corolla rotate, reflexed, fuscous, smooth except ciliated margin, tube half as long as calyx (1'), segments ovate-oblong ($2\frac{1}{2}$'): exterior crown narrow; scales of the interior yellow, membranaceous, inflated-ovoid, more than half as long as corolla, a little exceeding gynostegium: ovaries glabrate, stigma conical and minutely bifid: follicles not seen.—Santiago, Depart. Zacatepequez, alt. 6,500ft, 1891, Rosalió Gómez, (ex Pl. cit. 787).

Asclepias Guatemalensis.—Stem stout, simple, about a yard high, pubescent: leaves subopposite, oval (3–4 × $1\frac{3}{4}$–2in),

shortly acuminate, base cuneate, minutely scabrid above, flavescent beneath and with a pubescent conspicuous reticulation, lateral nerves approximate: peduncles 4–6, alternate at leafless summit of stem, linear-bracted; umbels many-flowered, pedicels exceeding flowers: calyx-segments linear-lanceolate (1′), pilose on back, margins scarious: corolla-segments four times longer, oblong, spreading, yellow: anthers equalling staminal column ($1\frac{1}{4}$′); coronal scales as long, white, cylindrical by involution of margins, rugulose, appendaged below sinuate apex with an as long incurved-subulate ligule: ovaries glabrous: follicles not seen.—The flowers of *A. ovata* Mart. et Gal., which may perhaps best be comparted with the above, differ by reflexed corolla, shorter pollinia and appendage of anther, conduplicate broad coronal scales ligulate from near base.—Santiago, alt. 6,500ft, 1891, Rosalió Gómez, (ex Pl. cit. 809).

Dictyanthus ceratopetala.—Hispid with spreading articulated hairs bulbous at base: leaves cordate-ovate ($2–3 \times 1–1\frac{3}{4}$in), about a half longer than petioles, acutely acuminated, minutely scabrid above, punctulate beneath and nearly glabrate except ferruginous nerves, margin ciliate: pedicels 2–8-fasciculate, 4-bracteolate, tetragonal, short, with peduncle added not equalling petiole and usually not exceeding calyx, flowers in anthesis single and about an inch long: calyx-segments lanceolate (6′): corolla glabrous, whole interior marked with elevated red-purple reticulations; tube semiglobose, a little exceeding calyx; limb divided nearly to tube; segments triangular, elongated (5–6′), obtuse, margins revolute: fruit not seen.—Of the other species with reticulated corollas, *D. reticulatus* Benth. et Hook. and *D. parviflorus* Hemsl., the former is the more nearly related, differing as briefly described by peduncles nearly as long as petioles and 1-flowered, ovate calyx-segments, twice larger flowers.—Plain of Santa Rosa, alt. 3,000ft, Aug. 1892, Heyde & Lux, (ex Pl. cit. 3,999).

Fimbristemma stenosepala.—Leaves acuminated-oblong or oblong-lanceolate ($4–6 \times 1\frac{1}{2}–2\frac{1}{2}$in), twice to thrice exceeding petioles: cymes subequalling leaves, pedicels distant and shorter than peduncle: calyx-segments subglabrate except margins, membranaceous, lanceolate, acute: corolla-segments broader and longer, apex apiculate and laterally erose: tube of corona short (2′), pilose; the exterior border narrow, entire, fimbriate; the interior fringeless, appendaged ex-

ternally with distant quadrate lobes: follicles not seen.—Similar in habit, and nearly so in structure of crown, to *F. calycosa* described and figured in vol. XVI, 196, pl. XVI, of this journal; that species differs chiefly by less developed inflorescence, somewhat larger flowers, large oval scarious sepals, glabrous tube of crown with its interior border simply divided into contiguous deltoid bidentate lobes. Borders of Lake Ayarza, alt. 8,000ft, Sept. 1892, Heyde & Lux, (ex. Pl. cit. 4,004).

Utricularia Verapazensis Morong.—A small plant with delicate 1–2-flowered scapes, 3 or 4cm high. Bladder-bearing branches at the base, few and short, running under moss; bladders ½–1mm long. Leaves radical, obovate, obtuse, 3–5-nerved, petiolate, about 5mm long, persistent. Scape bearing a solitary, minute, subulate scale midway or lower. Pedicels capillary, 5–7mm long, subtended by a deeply three-parted bract, the lobes linear-lanceolate, obtuse, half as long as the pedicel. Flowers 8mm or more in diameter, apparently purple. Calyx deeply parted; the lobes large, rounded, entire, nearly equal. Upper lip slightly angled on the broad, rounded apex; lower lip much larger, three-lobed, the middle lobe emarginate; both lips slightly pubescent near and upon the margins. Spur upturned, acute, one-third longer than the lower lip, minutely glandular-pubescent. Capsule not seen.—Related to *Utricularia Endresii* H. G. Reichb. f. of Costa Rica, which grows in similar situations. Reichenbach calls his plant (Gard. Chron., 1874, 582) a "lentibulariaceous orchid." (T. Morong.)—Tree-trunks near San Pedro Carcha, Depart. Alta Verapaz, alt. 3,000ft, Jan., 1887, Baron von Türckheim, (ex Pl. cit. 1,109).

TYNANTHUS GUATEMALENSIS, Botan. Gazette, XVIII, 6.

EXPLANATION OF PLATE XXII.—Fig. 1, flowering branch. Fig. 2, flower. Fig. 3, corolla laid open. Fig. 4, stamen. Fig. 5, pistil with interior of calyx. In figs. 2–5 the objects are variously enlarged.

Adenocalymna (?) Ocositense.—Glabrous: leaves conjugate, simply cirrhose; leaflets coriaceous, nitid, elliptical-oblong (5–7×1¾–2¾in), abruptly acuminated and mucronulate, base rounded, both sides punctulate and sparsely sprinkled with patelliform glands, costal nerves 7–8 to a side; petioles about an inch long, petiolules a half shorter and glandular-incrassate at base and apex: peduncle from bracteose axils subeqalling petioles and the 2–4-fasciculate pedicels; lower

bracts (*foliola stipuloidea* of Miers) imbricating, the upper decussate and rhomboid-lanceolate with scarious tips: calyx sparingly glandular, campanulate (3' high and broad), truncate, subdenticulate near margin: corolla puberulous, veiny, roseate and purplish, 3 inches long, tube narrowed gradually and not contracted at calyx, lobes more than half as long: stamens included: ovary ovoid ($1\frac{1}{4} \times \frac{3}{4}$'), closely glandular-tuberculate, lips of stigma semicircular, ovules regularly 1-seriate within margin of dissepiment.—In the absence of capsules the generic characters have not been satisfactorily verified.—Climbing high with flowers that fade to white, banks of the Rio Ocosito, Depart. Quezaltenango, alt. 250ft, April, 1892, J. D. S., (ex Pl. cit. 2,688).

Aphelandra Heydeana.—Fruticose: leaves membranaceous, nearly smooth, ovate to ovate-lanceolate or elliptical ($5–8 \times 2–3^{in}$), acuminate, more or less abruptly contracted and cuneately prolonged ($1\frac{1}{2}–2\frac{1}{2}^{in}$) into short petiole: rachis of solitary sessile spike short ($1–1\frac{1}{2}^{in}$), cano-pilose; bracts twice exceeding internodes, concave, nearly scarious, veiny, pubescent, obovate-oblong ($6 \times 3'$), prolonged into a half as long recurved convolute cusp, margins 1–2-spinulo-dentate: sepals subequalling bract, elongate-lanceolate, aristate, little exceeding the similar bractlets: corolla glandular-pubescent, crimson, $2\frac{1}{4}–2\frac{1}{2}^{in}$ long; posterior lip erect, oblong ($11 \times 3\frac{1}{2}'$), quite entire; anterior lip as long, broadly (6') obovate-oblong, lobes connecting lips lingulate (4'): capsules not seen.—Well marked by third part of leaf mostly simulating an alate petiole, squarrose spike, sepaloid bractlets, entire upper lip of corolla.—Chupadero, Depart. Santa Rosa, alt. 5,000ft, Oct., 1892, Heyde & Lux, (ex Pl. cit. 4,037).

EXPLANATION OF PLATE XXIII.—Fig. 1, flowering branch. Fig. 2, corolla laid open. Figs. 3 and 4, bracts Figs. 5 and 6, pistil with bractlets and sepals. (Figs. 1 and 2 are natural size; the others are slightly enlarged.)

PHYTOLACCA ICOSANDRA L., var. **octogyna.**—Leaves membranaceous, lanceolate-oblong, long-attenuate: bract equaling triquetrous pedicel (3–4'): sepals oblong ($2\frac{1}{2} \times 1'$), obtuse: stamens shorter, 14–18: styles 8: fruit depressed-globose, by abortion fewer-seeded. San Miguel Uspantán, alt. 7,000ft, April, 1892, Heyde & Lux, (ex Pl. cit. 3,031).

Tradescantia Guatemalensis C. B. Clarke (EUTRADESCANTIA).—Umbellis sessilibus bibracteatis, corolla intense cœrulea, antherarum loculis ovatis approximatis.—Stems procumbent,

rooting at nodes, pubescent on one side: sheathes 4–5' long, margins villose; leaves ovate-acuminate or ovate-lanceolate ($1\frac{1}{2}$–$3 \times \frac{1}{2}$–1^{in}), acute, equal at rounded or narrowed base, subpetiolate, both surfaces glabrous or pilose: bracts foliaceous in form and size, unequal in the pair; pedicels of terminal umbels elongate (16–20'), numerous, sparsely villose: sepals oblong ($3 \times 1'$), obtuse apex barbate: petals marked with undulate black lines: filaments pilose below, anther-cells adjacent and oblique, minute connective cuneate: capsule globose (2'), puberulous, seeds to the cell two and subquadrate or one and longer, strongly rugose. (J. D. S.)—Santa Rosa, alt. 3,000ft, April 1892, Heyde & Lux, (ex Pl. cit. 3,515); Volcan Pacaya, Depart. Amatitlan, alt. 9,000ft, July 1892, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 3,665); Lake Ayarza, Sept. 1892, Heyde & Lux, (ex Pl. cit. 3,886).

Tinantia leiocalyx C. B. Clarke.—Sepalis extus omnino (aut fere) glabris, sine glandulis; pistillo 12-ovulato; cetera T. fugaci Scheidw. similis.—Erect (4ft), branching, pubescence of stems scattered: leaves ovate ($2\frac{3}{4}$–$3\frac{1}{2} \times 1\frac{3}{4}$–$2^{in}$), acuminate, base rounded or sub-cordate, cuneately produced into petiole, pubescent above: peduncles and pedicels naked, smooth; bracts lanceolate (4'), bractlets none: sepals large, oblong (6–$7 \times 2'$), in flower a half longer than pedicels: longer filaments spiral, 2 broadly scariose-alate and albo-arachnoid below middle, the third exbarbate, anthers elliptical (1'); shorter filaments half as long, aureo-barbate at middle, anthers little smaller and circular. (J. D. S.)—Banks of the Rio Samalá, Depart. Retalhuleu, alt. 1,100ft, Oct. 1891, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 695).

Baltimore, Md.

On the development of the caryopsis.

RODNEY H. TRUE.

WITH PLATES XXIV—XXVI.

Historical.

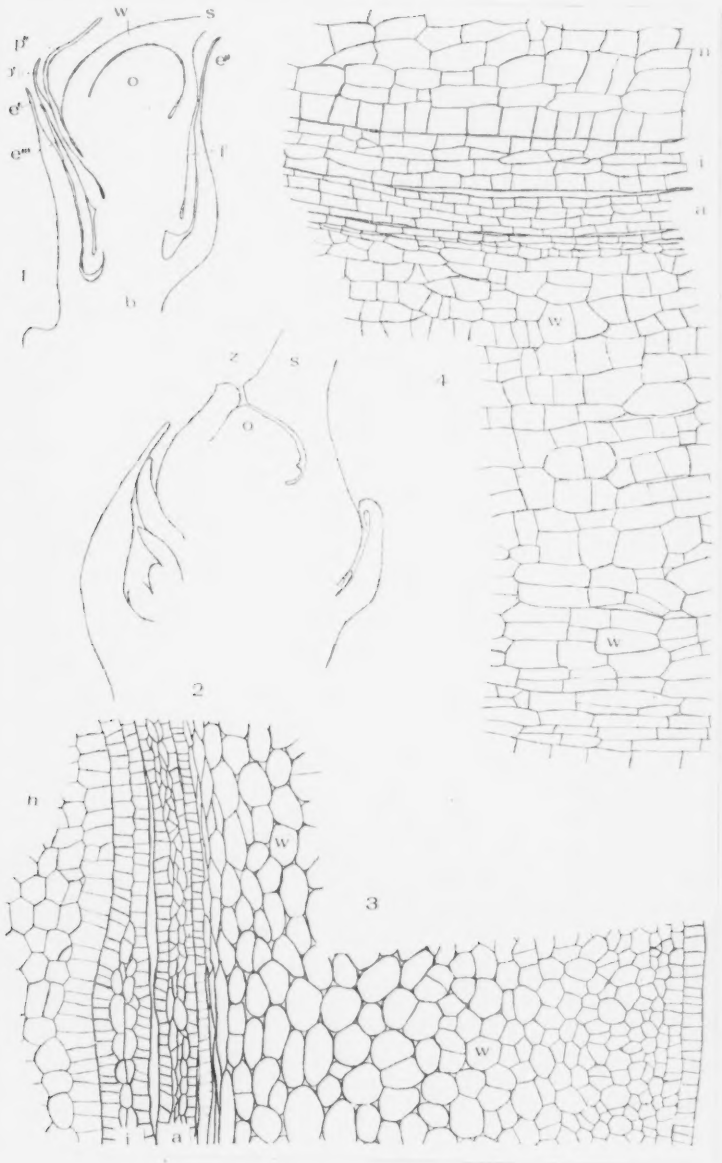
The structure of the fruit of the grasses seems to have received little attention prior to the beginning of the present century. During this period of increased interest in plant anatomy, some study was given to the structure of some of the commonest grains and even at this early date many observations were made that stood unquestioned until the last decade. Especially notable was the work done by Mirbel. He described for the first time the fruit of the Gramineæ and applied to it the name "*cerium*".[1] His definition was as follows: "A fruit in which, toward maturity, the ovary walls become united with the integuments of the seed. Richard[2], at a later date, gave the name of "*caryopsis*" to the same fruit defined in a similar way.

The researches of Schleiden[3] published in 1837 and in 1850 dealt with the fruit of the rye, *Secale cereale* L. In the earlier publication, the development of the grain was considered.

In 1870, Anton Nowaki[4] gave a condensed developmental history of the wheat grain and its envelopes.

In 1875, F. Kudelka published[5] the most complete account of the structure and the development of the common grains that had yet appeared. He described in great detail the development of the fruit of the rye from the time of the blooming of the flower to that of the ripeness of the seed. The general conclusions reached are substantially as follows: "Nie fehlende Schichten der Frucht- und Samenschale der Gramineen sind folgende: Die äussere Epidermis des Fruchtknotens, ein Theil des Parenchyms der Fruchtknotenwand, das innere Integument und die Epidermis des Knospenkerns. . . . In Folge von starkem Wasserverlust und Druck zur Zeit der Reife ist der innere Bau der Frucht- und Samenschale oft nicht deutlich erkennbar. Zusatz von Kali, wobei das betreffende Präparat aufquillt und dadurch mehr dem Stadium

[1] The index numbers refer to numbered titles in the bibliography at the close of this paper.



TRUE on the CARYOPSIS.

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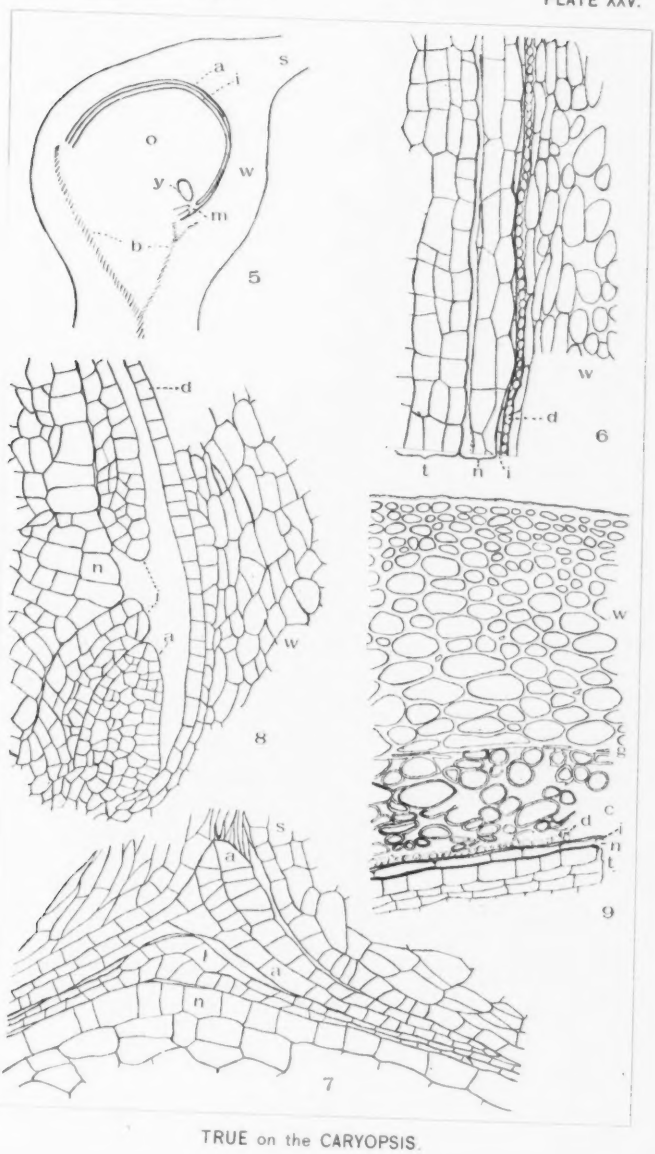

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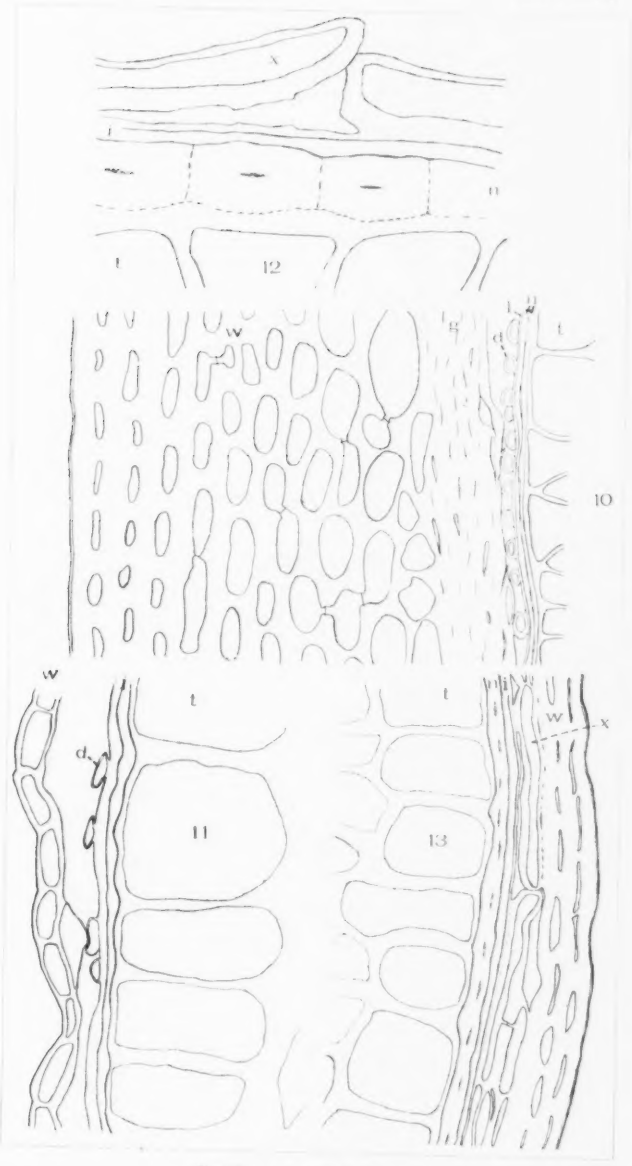

TRUE on the CARYOPSIS.

der Milchreife ähnlich wird, ist durchaus erforderlich zur genaueren Betrachtung der einzelnen Schichten." The descriptions were accompanied by a number of plates. The most important literature on the subject was critically reviewed in the light of his results. To this review, I am indebted for the résumé of a number of early articles to which I have not had access.

W. Johannsen brought out in 1885[6] the results of his study of the development and constitution of the endosperm of the barley. Although not included in his main subject of study, he gave attention to the fruit envelopes. In minor details only did he depart from the results previously obtained.

In 1888, H. Jumelle published[7] the results of his investigations concerning the constitution of the caryopsis. As his conclusions differed very widely from the hitherto generally accepted view, I quote them. "A aucun moment, pendant la maturation du grain des Graminées, il n'y a soudre entre les téguments de la graine et le péricarpe. Le péricarpe se résorbe en partié; les téguments de la graine disparaissent complétement. Le fruit des Graminées ne mérite pas un nom spécial; c'est un akène renferment une graine sans tégument." Detailed observations on the wheat were given in the article, but other cereals were studied and all contributed to the results quoted.

In the same year, the same conclusions were announced in an article of wider scope.[8]

A. Zoebl made an investigation in 1889[9] of the structure of the envelopes of the seed of the barley, *Hordeum distichum* L. After describing in detail the structure of the outer envelopes, the seed coats in the mature specimen were described in substance as consisting of two layers of cells united without spaces. The outer is much heavier than the inner which is often described as the "hyaline layer."

The latest reference to the subject that has come to my notice is found in Van Tieghem's Traité de Botanique, where I find this statement: "Chez les Graminees, le tégument externe de ovule est resorbé comme le tégument interne, et la membrane des sac embryonnaire vient s'accoler intimement contre le face interne des pistil. La graine y est depourvue du tégument."[10]

Introductory.

The question involved in these discussions is one of some importance. The existence of the *caryopsis* as a type of fruit distinct from the *achene* has not been challenged, so far as I have been able to learn, until 1888 by Jumelle in the above cited articles. The adoption of his view and the incorporation of it into so important a treatise as that of Van Tieghem is likely to lead to confusion. To determine whether the earlier and accepted view or that of Jumelle is correct has been the object of this investigation.

To this end a careful study has been made of the history of every part concerned from the time of the fertilization of the ovule to that of the complete ripening of the seed in the corn *(Zea Mays* L.), wheat *(Triticum vulgare* Vill.), and the oat *(Avena sativa* L.). As the developmental history of the fruit of the corn has received less attention heretofore than that of the other common cereals, I have described it with some detail. The wheat and oat receive briefer mention.

The grains used were collected from fields near Baraboo, Wis., during the summer and fall of 1890. The material used was gathered at suitable stages of development from plants of typical growth, and while fresh was immersed for from twelve to twenty-four hours, according to its bulk, in a solution of chrom-acetic acid. The following proportions by volume were used: saturated solution of chromic acid, 3 parts; acetic acid, 7 parts; rain water, 990 parts. To enable more rapid and complete penetration of the tissues of the corn to take place, the young axes were cut into small pieces. From the acid the material was transferred to weak alcohol after the removal of the surplus acid by thorough and repeated washing in rain water. After gradual hardening in alcohol of increasing concentration it was placed in commercial alcohol for permanent preservation. The younger stages were imbedded in paraffin and serial sections were cut with the microtome. Older grains were cut free hand. The use of potassic hydrate was found advantageous in studying much compressed tissues to swell them.

Zea Mays L.

At the time of the maturation of the egg apparatus, the ovary is unsymmetrical in form, being bent from the perpendicular in such a manner as to cause the long style, or "silk"

of popular phrase, to point in the direction of the end of the spongy, club-shaped axis, the cob, fig. 1. At this stage, the ovary is about 2.5^{mm} long and at the point of greatest width, the base, has a diameter of about 3^{mm}. It is raised on a thick pedicel about 2.5^{mm} in height. Attached to the sides of this pedicel and wrapped up closely about the ovary so as to nearly cover it, are the glumes and palets in the form of more or less fleshy scales. These parts occupy the characteristic positions in the flower. The two broad, fleshy outer glumes with fimbriated edges cover the more delicate flowering glume on one side and the third empty glume and the two palets on the other. The single ovule is attached by more than a third of its circumference directly to the floor of the ovary. The funicle is, therefore, not present. The ovule is very large and nearly fills the cavity of the ovary. Its form, like that of the ovary, is unsymmetric being so strongly curved as to be decidedly campylotropous. At this stage, the integuments of the ovule are fully developed, fig. 5. The micropyle is situated on the side adjacent to the flowering glume just above the point of attachment. The outer integument is incomplete, failing to cover an area extending from the micropyle to the base of the style, in length, and in width equal to about one-half the diameter of the ovule. It is present between the micropyle and the base of the ovule in the form of a short tongue-shaped projection. The inner integument forms a complete covering except at the micropyle.

The wall of the ovary at this stage attains a greater thickness than at any other time in its history, its average thickness being about 0.4^{mm}. It is bounded externally by an epidermis composed of cells containing large nuclei. The parenchyma forming the bulk of the wall consists of rounded and short-prismatic cells. In the outer third of the wall, the cells are much smaller and more elongated than those of the deeper parts. Hence intercellular spaces while very rare in the former region, are abundant and large in the latter. The cells of the inner two-thirds are large, rounded and necessarily more loosely arranged. The dividing line between these regions at this stage is not sharply defined, but later becomes very evident. Adjacent to the inner epidermis are two or more layers of small cells which are elongated in a direction transverse to the longitudinal axis of the ovule. The inner epidermis consists of small, nearly cubical cells.

Over the greater part of its surface, the outer integument is in contact with the ovary wall. Figs. 3, 4.

In a considerable number of specimens, a pit was observed a short distance from the base of the style, on the posterior side. In some cases the depth of the pit at this stage was equal to one-half the thickness of the ovary wall. The edges were rounded and complete, showing that this space was due to a failure of the parts to unite completely. In younger specimens in which the embryo-sac had not yet developed, this pit was generally to be found. In many of these cases, the pit extended entirely through the ovary wall exposing the already developed outer integument. It seems that at this stage of development, the edges of the carpel have not yet completely united. Fig. 2.

The outer integument is, in the main, four layers of cells in thickness. Toward the top of the ovule it is reduced to two layers, except at the base of the style where it is thickened into a broadly wedge shaped mass which projects for a short distance into the base of the style, fig. 7. The short portion projecting over the anterior face is terminated by a single layer of wedge shaped cells. This integument is for the greater part in close contact with the ovary wall on the outside and with the inner integument on the inner side, but anterior to the base of the style there is often a considerable space between it and the ovary wall. As this region is traversed by the descending pollen tube, it is possible that it may aid in determining its course. The cells constituting this integument are generally short-prismatic, rather regular and have very thin walls, figs. 3, 4. The short wedge-shaped portion found below the micropyle is in close contact with a similar part of the inner integument, but is removed from the ovary wall by a considerable space, fig. 8.

The inner integument varies in thickness from four layers of cells near the base of the ovule to two toward its apex. The cells as in the outer integument are short-prismatic in form but are considerably larger. The inner integument is closely in contact with the nucellus. At no points are the integuments strictly united with any of the adjacent organs save only at the points of their origin. At intervals, narrow spaces may be seen between adjoining structures. The function ascribed to the integuments seems to be that of protection to the parts enclosed. Holzner[11] regards it as probable that they

serve in some degree to give direction to the pollen tube. Hackel[12] says that the outer integument of the ovule of the Gram neæ "has very delicate walls, and forms a conductive tissue for the pollen tube upon the anterior side." Figs. 3, 4.

The nucellus consists of large isodiametric cells with small nuclei and scant contents. It is bounded by an epidermis with strongly cutinized outer walls. This cuticle is conspicuous in all stages of growth by reason of its great affinity for staining fluids. Toward the base of the nucellus, in its anterior part is found the embryo sac. In this grain it is very large, being readily sectioned even by free-hand methods.

For a very short time after fertilization no general change is noticeable in the ovule outside of the embryo sac. As the embryo and endosperm increase in size, they begin to exert a pressure on the adjacent tissue of the nucellus. Signs of yielding begin to be manifest here soon. Even earlier, in fact shortly after fertilization, the outer integument begins to show signs of weakening at the apex of the ovule near the base of the style. Soon after, the walls of the cells toward the outer surface of the young pericarp begin to thicken, especially those adjacent to the epidermis. The disintegration of the outer integument proceeds now more rapidly and it becomes increasingly difficult to detect the cell walls owing to their partial absorption and collapse. The first point of complete disappearance is at the apex of the ovule.

Previous to the collapse of the outer integument, the inner integument shows little change. Shortly, however, a slight tendency to weaken is seen, especially in the external layer of cells. In many the partitions become wrinkled. That a considerable pressure is exerted from within, is shown by the close contact of the inner integument with the ovary wall in places where the outer integument has disappeared. The nucellus is forced to undergo increased compacting to make room for the growing embryo and endosperm.

At a somewhat later stage, profound changes in the pericarp begin to manifest themselves. Toward the top of the ovule, the large-celled, thin-walled parenchyma of the middle and inner parts of the ovary wall begins to weaken and a crumpling or collapse, together with a compacting, of the cell walls becomes conspicuous. The outer boundary of the region in which this change takes place, is rather regular and is very

definite. It extends nearly parallel to the inner epidermis at a distance from it of about one-third the thickness of the ovary wall. Fig. 9.

As a result of resorption, the rounded cells within this region are freed from each other leaving the original tissue represented by a stratum of detached cells. Absorption may go further leaving but indistinct remnants of some of the cells themselves.

This disintegration affects in less degree the inner epidermis and the adjacent elongated cells. The combined influences of partial disintegration and of pressure transmitted from the growing embryo separate the epidermal cells laterally. As a result, instead of forming a sheet, the epidermis has come to consist of ribbons of cells attached by their ends alternating with narrow spaces of approximately equal width. In short, the deeper tissues of the ovary wall in the region of the apex of the ovule have undergone a more or less complete disintegration. The walls of the outer epidermal cells and a few layers of cells beneath it, show some thickening, and in the walls of the latter cells, pits are noticeable.

At this stage the outer integument has entirely disappeared, fig. 6. The cell walls of the inner integument begin to weaken and collapse, but the layer can be easily seen in cross sections. Of the nucellus only two or three layers of cells remain except at the base of the ovule, where a considerably thicker and much compacted body of cells is found. The greater part of the missing tissue has been absorbed, but evidence of compression is found in the form of collapsed cells adjacent to the endosperm and embryo.

The cells of the endosperm are very thin walled and contain large nuclei and granular protoplasm. The peripheral cells are smaller and richer in protoplasm than those of the interior parts, the latter containing large vacuoles. The cells of the embryo are smaller than those of the endosperm and are in an active state. The use of proper stains brings out well the details of nuclear division in these cells. Even at this early stage the glandular layer is distinctly differentiated as small epidermal-like superficial cells.

As development continues the modifications indicated in earlier stages become more and more pronounced. The thickening of the walls of the outer epidermis of the ovary

and the underlying parenchyma continues; the disintegration in the inner parts extends toward the base of the ovule on all sides and becomes more nearly complete. The strips of cells representing the inner epidermis become more widely sundered.

For the most part the inner integument suffers compression of its elements and can be distinguished with difficulty. Of the nucellus nearly all the cells suffer absorption. An exceptional region is seen at the base of the ovule. Here a considerable quantity of the compressed tissue remains, persisting, in fact, even in the mature fruit. The epidermis of the nucellus with the strongly cutinized outer surface resists absorption, and although suffering compression may be readily recognized by the deeply stained cuticle.

The endosperm cells begin to assume their characteristic appearance. The aleurone layer contains abundant protein grains and the thickening of its cell walls is noticeable. The interior cells contain a few starch grains of the usual size and many smaller granules. The cell nuclei are still present.

From this stage to that of ripeness, the change is quickly made. In the mature grain the walls of the outer epidermis of the pericarp and the underlying parenchyma are so strongly thickened that the lumina are almost reduced to lines, fig. 10. The pitting of the walls is rendered conspicuous by treatment with a 5 per cent. solution of potassic hydrate. A distinct cuticle bounds the epidermis, but the underlying walls are rarely cuticularized.

Between the outer intact part of the ovary wall and the inner disintegrated region, lies a narrow line of compressed cells and débris. This compression seems to be the result of the outward pressure exerted by the growing embryo and endosperm. The resorption of the inner parts progresses until few or no detached cells or walls or remnants remain. There is thus formed an irregular cavity bounded externally by the jagged line of compacted remains and bounded internally by the sundered parts of the inner epidermis and the inner integument. As the growth within continues, this jagged gap is lessened in width until in the mature grain the limits come to lie adjacent to each other, fig. 10. In places, the inner epidermal cells are in contact with the line of compacted cells. In the mature grain, the lumina of these compacted cells appear to be mere striations and the limits of the individual cells are visible only upon treatment with potassic hydrate.

In places, small portions of the inner epidermis seem to have been resorbed, but generally its separated elements persist and become united to the adjacent inner integument. This union is distinctly seen under high magnification after treatment in warm potassic hydrate. This soldering together of ovary wall and integument takes place late in the history of the fruit, probably after the "green-ripeness" of Kudelka. Occasionally cells of the inner epidermis are found soldered to the compacted cells of the ovary wall indicating that the union took place after the two tissues had been brought near together. As a result of compression and resorption, the ovary wall having an average thickness of about 0.4^{mm} at the time of flowering has been reduced to a thickness of about 0.145^{mm} in the ripe fruit.

In a ripe grain, the inner integument is visible only after treatment with potassic hydrate, and then in radial and cross sections of the grain as a line only. In tangential sections only is its cellular structure distinguishable. In close contact with it is the epidermis of the nucellus. This is likewise strongly compressed but the lumina of its cells can be detected after treatment with potassic hydrate. In stained sections the cuticle is conspicuous. At the base of the seed may be seen a considerable mass of the nucellus tissue. This is distinctly visible to the unaided eye as a small area of whitish color near the point of attachment of the seed. The aleurone layer has very strongly thickened walls at maturity which are found to be beautifully stratified after treatment with potassium hydroxide. At ripeness, the cells of this layer are closely packed with their characteristic contents. The interior cells of the endosperm have thinner walls and are closely packed with food materials consisting in the main of starch.

Triticum vulgare Vill.

As the developmental history of the wheat and of the rye has been described with a greater degree of completeness than the corn, I shall here give very briefly the results reached in the study of the wheat.

At the time of the maturation of the ovule, the ovary is broadly conical in outline with the apex directed downward. The posterior side is traversed for nearly its entire length by

a groove which marks the position of the fibro-vascular bundle and also shows in a general way the position and extent of the attachment of the ovule to the ovary. The broad upper part of the ovary is thickly beset with rather coarse hair-like trichomes. The ovule is strongly campylotropous, being attached along its side to the ovary, carrying the micropyle at the lower end.

The ovary wall is of irregular thickness, in general becoming thicker toward the top of the ovary. It consists of an outer epidermis, many layers of rounded parenchyma generally looser in the deeper parts of the wall than near the outer epidermis, a single layer of cubical chlorophyll-bearing cells and a delicate inner epidermis. Near the furrow, the chlorophyll-bearing cells may frequently form a double row.

The integuments arise along the posterior side of the ovule and are complete except at the micropyle. They each consist very uniformly of two layers of cells with delicate walls. The enclosed nucellus is of a somewhat conical outline and is composed of the characteristic thin walled parenchyma tissue bounded by a distinct epidermis. The integuments are in contact with the ovary wall, with the nucellus and with each other, but at this stage are not structurally connected.

After fertilization the first marked change is the weakening of the elements of the outer integument. They become gradually more and more indistinct until the integument disappears entirely. In the ovary wall, the first change is seen in the parenchyma just external to the chlorophyll-bearing layer. A broad zone of this tissue is gradually absorbed leaving the outer epidermis and from two to four layers of the underlying parenchyma still intact. The inner epidermis also gradually disappears either completely or in great part. The nucellus as a matter of course undergoes very early changes. The cells about the young embryo and endosperm are compressed and resorbed to make room. These changes in the various parts proceed with considerable rapidity.

As the fruit develops, the processes of modification above mentioned continue. The chlorophyll cells elongate tangentially and assume a somewhat canoe-shaped outline when seen in cross sections of the grain. The cells lose their chlorophyll and the walls become strongly thickened and conspicuously pitted. Of the inner integument, both layers

of cells persist. As development goes on, the outer layer becomes inconspicuous on account of the obliteration of the cell lumina and the almost hyaline appearance of the walls. The inner layer suffers less compression usually on account of the thicker walls, but often treatment with potassic hydrate is necessary to bring out the elements. With the exception of the region near the fibro-vascular bundle and the epidermis, the nucellus is eventually all resorbed. The epidermis persists in a compressed condition.

At maturity, the ovary wall outside of the chlorophyll layer consists of two or three rows of cells with strongly thickened walls and narrowed lumina, fig. 13. The space formerly occupied by the absorbed portion of the wall has been filled by the outward movement of the inner growing parts thus bringing the chlorophyll layer in contact with the remaining cells of the ovary wall. The remaining cells of the inner epidermis, when present, and, in their absence, the former chlorophyll-bearing cells, are soldered to the hyaline outer layer of the inner integument and sometimes also exteriorly to the adjacent cells of the wall. Of the existence of this union, I think there can be no doubt. The inner integument, said by Jumelle to be absent, was present in every specimen I have examined and is plainly distinguishable under moderate magnification in specimens that have been treated with potassic hydrate. The hyaline outer layer is not easily demonstrated, but the thicker walled inner layer is readily seen, fig. 12.

In "red" wheats, particularly, this is true, since in the cell cavities of this layer is deposited a quantity of rusty red coloring material that catches the eye at once. The difference in color between the so-called red and white wheats depends on the presence or absence of this coloring matter in the inner integument. As far as I have been able to ascertain, this layer of cells is always present in the white wheats but is less conspicuous than in the red.

Thinking that possibly a difference between American and European varieties might account for the different results I have reached from Jumelle, I obtained through the kindness of the Department of Agriculture a number of specimens of European wheats which I examined with this possibility in mind. These however exhibited the same structures as

already described. I am therefore compelled to dissent from Jumelle's conclusions, which Van Tieghem has adopted in his voluminous treatise.

The epidermis of the nucellus is seen in mature specimens after treatment with potassic hydrate, but with well nigh obliterated lumina, fig. 13.

Avena sativa L.

At the time of flowering, the ovary of the oat differs in appearance from that of the wheat chiefly in the more complete covering of hairs. As development proceeds, however, other and more fundamental differences appear. Owing to the assumption by the bracts of the protective function, the pericarp is thinner and more delicate than in the grains described above. Resorption of the ovary wall goes further than in the corn and wheat, fig. 11. The chlorophyll cells as well as the inner epidermis and a greater part of the ovary wall disappear. As a result, in the ripe fruit, the pericarp comes to consist of the outer epidermis and a layer or two of adjacent interior cells only. As in the wheat, the outer integument disappears and the inner persists. It is very delicate, however, and in the ripe fruit reveals its structure only upon treatment with potassic hydrate. In fig. 11 the layer adjacent to the endosperm is the epidermis of the nucellus. The inner integument, *i*, includes only the layer external to this.

The soldering of adjacent elements of integument and pericarp takes place less freely than in the corn and wheat. Owing to the great absorption of the tissue of the ovary wall, the remaining part comes to approach somewhat the condition of the loose utricular covering. As growth from inside progresses, the integument approaches this loose remnant, and in places eventually comes in contact, but never so closely as in the wheat. As a result, the pericarp is soldered to the integument at fewer points and is removed with less difficulty. The epidermis of the nucellus persists, but is plainly distinguishable only after treatment with potassic hydrate.

Some other fruits of the Gramineæ were examined, but less carefully than those described above. The results obtained were in the nature of corroboration of the doctrine that the pericarp and integument unite in the fruit of the grasses.

As further opportunity shall permit, it is my intention to examine at different stages of development the fruits of related plants to ascertain, if possible, how widely this history is the history of other forms.

Summary.

I summarize my results and conclusions as follows:

I.—In the corn, wheat and oat, at the time of fertilization, the single ovule is furnished with two integuments, which are more or less complete. As development proceeds (1) the outer integument soon disappears; (2) the inner cells of the ovary wall are absorbed in varying proportions; (3) the tissue of the nucellus is absorbed, with local exceptions.

II.—At maturity, these remain as seed coverings: (1) the external portion of the ovary wall, in varying proportion, forming the pericarp; (2) the inner integument persisting in a state of compression. The epidermis of the nucellus also persists, though much compressed.

III.—Late in the development of the fruit, the remaining (inner) integument becomes soldered to the adjacent inner cells of the pericarp forming the fruit correctly described by Mirbel under the name of "cerium," and rechristened by Richard the "caryopsis."

This investigation was pursued in the botanical laboratory of the University of Wisconsin, under the direction of Prof. Charles R. Barnes. For his kind suggestions and help I wish to express my sincere gratitude.

Madison, Wis.

Bibliography.

While the literature of the development of the grains and, in an incidental and general way of their coverings, is somewhat extensive, few papers give to the coats a detailed study. I have here listed only those writings which touch most directly and definitely upon the subject in hand and such, therefore, as would be most useful for general reference.

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7. Jumelle, Henri: Note sur la constitution du fruit des Graminées. Compt. Rend. CVII, 285.—Same abstracted in Just's Bot. Jahresber. 1888, 788.
8. Jumelle, Henri: Sur les graines à deux téguments. Bull. de la Soc. Bot. de France, 1888, p. 35.—Abstract in Just's Bot. Jahresber. 1888, p. 748.
9. Zoebl, A.: Der anatomische Bau der Fruchtschale der Gerste, *Hordeum distichum* L. Verh. d. naturf. Vereins in Brünn, XXVII (1889). 26.—Abstract in Bot. Centralb. 1890, p. 179.
10. Van Tieghem, P.: Traité de Botanique, I. 924. Paris, 1891.
11. Holzner: Bot. Centralb. XII (1882). 107.
12. Hackel, E.: True Grasses, translated by Scribner and Southworth. Henry Holt & Co., N. Y. 1890.

EXPLANATION OF PLATES XXIV–XXVI.—Abbreviations used: *a*, outer integument of ovul.e—*b*, pedicel bearing the flower (Fig. 1); fibro-vascular bundle (Fig. 5.).—*c*, area of disintegration —*d*, inner epidermis of ovary wall.—e', e'', e''', empty glumes in order.—*f*, flowering glume.—*g*, line of compacting of cells in ovary wall.—*i*, inner integument of ovule.—*m*, micropyle.—*n*, nucellus.—*o*, ovule.—*s*, base of style —*t*, endosperm.—*w*, wall of ovary.—*x*, chlorophyll bearing layer of ovary wall.—*y*, embryo sac.—*z*, pit in ovary wall near base of style in young ovules.

PLATE XXIV.—Fig. 1. Longitudinal antero-posterior median section through the ovary of the corn at the time of the maturation of the ovule. × 30.

Fig. 2. Same view of the young ovary prior to the formation of the embryo sac showing the pit near the base of the style. × 45.

Fig. 3. Transverse section through the median region of the ovary wall and integuments of the corn at the time of blooming. × 325.

Fig. 4. Longitudinal view of the same parts at the same stage. × 325.

PLATE XXV.—Fig. 5. View of the ovary and contents of the corn seen in median longitudinal antero-posterior section. × 45.

Fig. 6. Longitudinal section of the inner coverings of the ovule of the corn. Disintegration appears in the ovary wall, the outer integument has disappeared and the nucellus suffers compression. × 325.

Fig. 7. Antero-posterior longitudinal section of the integuments in the ovule of the corn showing the wedge-shaped thickening of the outer integument projecting into the base of the style. × 325.

Fig. 8. View of the integuments at the micropyle as seen in the longitudinal median section of the corn. × 325.

Fig. 9. Transverse section of coats, etc., in the middle region of the ovule of the corn. The line of compacting in the ovary wall has formed, the innermost cells are freed, the inner integument is compressed, the epidermis of the nucellus remains. × 325.

PLATE XXVI.—Fig. 10. Transverse section of the coats of the corn grain at maturity after treatment with cold potassic hydrate. × 400.

Fig. 11. Transverse section through the coats of the mature oat grain showing the union of the remaining cells of the ovary wall with the inner integument. The layer to the left of *i* is the inner integument; to the right, the epidermis of the nucellus × 465.

Fig. 12. Transverse section of the inner coverings of the mature wheat grain, showing union of the chlorophyll cells of the ovary wall with the inner integument after treatment with KOH. × 735.

Fig. 13. Transverse section of the coverings of the mature wheat grain. × 465.

Contribution to the biology of the organism causing leguminous tubercles.

GEO. F. ATKINSON.

WITH PLATES XII–XV.

[Continued from p. 166.]

Historical resume.

Early period of investigations.

The tubercles were at first supposed to be normal parts of the plants on which they were found. According to Vuillemin[6], De Léchamp[7] named the genus *Ornithopus* from the character of the tubercles and De Candolle[8] uses the form of the tubercles as one of the characters of a variety of *Ornithopus perpusillus*.

Bivona[9] took them to be fungi of the genus *Sclerotium* and distinguished two types, the simple ones as *S. lotorum* and the lobed ones as *S. medicaginum*. Persoon's *Sclerotium rhizogonum*[10] was also founded upon certain of these tubercles. Fries[11] rejects Persoon's *S. rhizogonum* referring the forms on

[6]Les tubercles radicaux des Légumineuses. Ann. d. Sci. Agronom. franç. et etrang. 1888. p. 96.

[7]Histoire générale des plantes. 1615.

[8]Prodromus Syst. Nat. Reg. Veg. II (1825). 312.

[9]Pugill. plant. rar., Siculæ, IV. 26.

[10]Traité sur les champignons comestibles, Paris. 1818.

[11]Systema Mycologicæ, II. 250.

which it was based to growths from the roots of *Vicia*, etc. Fries however retains Bivona's two species *S. lotorum* and *S. medicaginum* and it was reserved for Tulasne[12] to cast them out of the category of fungi. To A. P. DeCandolle[13] they resembled small fungi like *Sclerotium* but he regarded them as diseased outgrowths and Wigand[14] recently has looked upon them as pathological forms.

Jessen[15] doubts their parasitic origin, and Clos[16] believed them normal structures with a physiological role and called them lenticels.

Others saw in them the products of animal parasitism, Malpighi[17] giving to insects the credit of their origin while Cornu[18] preferred to charge them to the account of *Anguillulidæ*. Later he withdrew the charge and treated them as root branches.[19]

Those who have argued that the tubercles were normal organs of the Leguminosæ hold very diverse views as to their function in the plant economy. Gasparini[20] describes them as swollen lateral roots and with Kolaczek[21] thought they were organs for absorbing food. DeVries[22] and Wittmack[23] interpreted them as lateral roots with dwarfed growth, while Treviranus[24] judged they were imperfect buds which in case

[12] Fungi Hypogaei. 1851.

[13] Mémoire sur les Légumineuses. 1825.

[14] Bakterien innerhalb der geschlossenen gewebes der knollenartigen Anschwellungen der Papilionaceen Wurzel. Bot. heft. Forsch. aus dem Bot. Gart. Z. Marburg, 1887, p. 88, cited by Pichi, Atti della Società Toscani di scienze naturali, 1888.

[15] Sitzungsbericht d. Bot. Verein d. Prov. Brandenburg, 1878. p. 54.

[16] Ebauche de la rhizotaxie, 1848; Du collet dans les plantes et de la nature de quelques tubercles. Ann. d. Sci. Nat. Bot. III. XIII. 1849.

[17] Anatome Plantarum pars sec. de Gallis. Opera I. 1687, cited by Vuillemin, l. c. See also Sorauer, Pflanzenkrankheiten. I. 744; Frank, Krankheiten der Pflanzen.

[18] Commission du Phylloxéra. 1876.

[19] Etudes sur le Phylloxera vastatrix. Memoires de l' Académie des sciences. XXVI. 1878.

[20] Osservazioni sulla struttura dei spongiolari di alcune piante leguminose, Lette all. Ac. di Napoli, 1851; cited by Tschirch, Ber. d. deutsch. bot. Gesells. V (1887). 58.

[21] Lehrbuch der Botanik, 1856. p. 374.

[22] Wachstumsgeschichte des roten Klees. Landw. Jahrb. von Theil 6, 1, 1877; Verhandlung d. Bot. Vereins d. Prov. Brandenburg. 1878. p. 54–55.

[23] Verhandlung d. Bot. Vereins d. Prov. Brandenburg. 1874. p. 54.

[24] Ueber die Neigung der Hülsengewächse zu unterirdischer Knollenbildung. Bot. Zeit. 1853, p. 393. See Vuillemin.

the plants did not fruit could themselves develop into perfect plants. According to Nobbe,[25] Lachman,[26] Mattirolo e Buscalioni[27] they were places for the storage of reserve food materials.

These notions were probably empirical and derived more from superficial examination than from any serious attempt at an anatomical study of their structure and contents.

Middle period of investigations.

The period of serious investigation into their structure and etiology begins with Woronin's[28] contribution in 1866. He described the tubercles as being composed mainly of a parenchymatous tissue which is separated into an inner central mass and an outer layer, the two portions being separated by a layer of fibro-vascular tissue which arises from corresponding tissue in the central cylinder of the root. The inner parenchyma he described as possessing turbid contents while the outer was clear. The growing point or meristem of the tubercle lies in the distal portion of the inner parenchyma, the proximal portion being occupied by bacteria-like bodies or vibrios which filled the plasmic substance. These he considered to be the cause of the tubercles.

The next important contribution was by Eriksson[29] who distinguished what he supposed were two organisms in the tubercles. One he verified as the vibrio-like bodies discovered by Woronin which occupy the proximal portion of the central parenchymatous tissue. In the distal portion of the central parenchymatous tissue he discovered what he took to be fungus strands lying in a radial position, branching into finer threads as they approached the center. He described

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[25] Vegetationsversuche in Boden mit lokalisirten Nährstoffen. Landwirtschaftliche Versuchstationen, 1868, p. 98.

[26] Ueber Knollchen der Leguminosen. Landw. Mittheil. Zeitschr. d. k. Lehranstalt und Versuchstationen, Poppelsdorf, 1856, p. 37. Cited by Tschirch, l. c.

[27] Si Contengono bacteri nei tubercoli radicati delle Leguminose? Malpighia I, *21*, 464, cited by Pichi, l. c.

[28] Ueber die bei der Schwarzerle und der gewœhnlichen Garten-Lupine auftretenden Wurzelanschwellungen, Mem. d. l' Acad. Imp. d. Sciences, VII. x. (1866) 2.

[29] Studier öfver Leguminosernasrotknölar, Lund, 1874; Bot. Zeitung, 1874, p. 381. Cited by Vuillemin, l. c. and others

also the characteristic enlargements of these structures where they pass through the cell walls. He believed these fungus hyphæ to be the real cause of the tubercles.

DeVries[30] observed the hyphæ described by Eriksson but did not believe they stood in causal relation to the tubercles.

Schindler[31] also detected the hyphæ but claimed they enter after the tubercles begin to degenerate, while Cornu[32] and Mattei[33] declare there exists no mycelium in the tissues.

Kny[34] recognizes the presence of strands but denies the presence of a membrane. He believed they were strands of a plasmodium similar to Woronin's *Plasmodiophora brassicæ*[35] and about this time Woronin[36] retreats from his former position that the tubercles were caused by bacteria or vibrio-like bodies, and believes them to be due to a plasmodium, being influenced probably by his studies upon the club-foot of cabbage.[37] Prillieux[38] largely corroborated the studies of Eriksson, especially in regard to the structure of the tubercles and their parasitic origin, but believed them to be caused by a plasmodium, related to Woronin's *Plasmodiophora brassicæ*, which excretes a viscid substance.[39]

In 1879[40] appeared B. Frank's first important paper on the subject. He found both the hyphæ and the bacteria-like bodies. He believed the latter sprouted off from the former. In an earlier publication[41] he thought the fungus to be closely allied

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[30] Wachstumsgeschihcte des roten Klees. Landw. Jahrb. 1877.

[31] Ueber die biologische Bedeutung der Wurzelknœllchen bei den Papilionaceen. Jour. f. Landw. XXXIII, (1885), 325–336. Ueber die Bedeutung der sog. Wurzelknœllchen bei den Papilionaceen. Œsterreich. landw. Wochenblatt XI (1885), n. 34, cited by Tschirch, l. c. Zur Kenntniss der Wurzelknœlchen der Papilionaceen. Bot. Centralb. XVIII (1884), 86.

[32] Mem. d. l' Acad. d. Sciences, XXVI (1878).

[33] Ancora sull. origine della Vicia faba. Bologna, 1887, cited by Vuillemin. l. c.

[34] Verhandlung. d. Bot. Vereins der Prov. Brandenburg, 1877. Ueber die Wurzelanschwellungen der Leguminosen und ihre Erzeugung durch Einfluss von Parasiten. Ibid. 1878.

[35] Pringsheim's Jahrb. f. wiss. Bot. XI, 548.

[36] Ibid., p. 371.

[37] Ibid., p. 548.

[38] Sur la nature et sur la cause de la formation des tubercles qui naissent sur les racines des Légumineuses. Bull. Soc. Bot. d. France, 1879, p. 98.

[39] Comptes Rendus d. sc. Paris, CXI, 926.

[40] Ueber die Parasiten in den Wurzelanschwellungen der Papilionaceen. Bot. Zeitung, XXXVII (1879), n. 24, 25.

[41] Leunis: Synopsis: Kryptogamen, p. 1,944.

to the genus Protomyces of De Bary,[42] but now he transfers it to the genus *Schinzia* founded by Nægeli[43] on a fungus which causes galls on the roots of *Cyperus*, and calls it *Schinzia leguminosarum*, thus considering it to be closely related to the fungus in galls on the roots of Alnus first described by Woronin.[44] It is quite important in view of Frank's change of opinion at a subsequent date to note that an examination of the illustrations and descriptions which accompany this paper leaves no doubt that at that time he considered the bacteria-like bodies to be budded off from the hyphæ though he did not actually see the budding take place. This paper of Frank's brought out a rejoinder from Kny[45] who states that the bacteria-like bodies are the spores of the plasmodium.

The general effect of these investigations was to give a feeling of confidence in the view that the etiology of the tubercles was primarily due to the irritating or stimulating influence of some organism in the soil, though there was great diversity of opinion as to the character of the organism.

This feeling of confidence, however was soon shaken by the appearance in 1885 of a paper by Brunchorst.[46] Brunchorst claims that the tubercles are not caused by any organism. He affirms the older views that they are normal structures. To the vibrio-like bodies he ascribes an entirely new role. He believes them to be differentiated portions of the plasmic protein contents of the cells. While they possess the form of bacteria they are inert and serve as receptacles for the storage of proteid substance by the plant since they were found to be exceedingly rich in protein matter and that later their contents are absorbed by the plant. Because of their morphological resemblance to bacteria Brunchorst termed them bacteroids. He observed the fungus hyphæ but did not consider them to stand in causal relation to the tubercles since he found none

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[42] Beiträge zur Morph. u. Phys. d. Pilze, I.

[43] Sur des Champignons vivant dans l' interieur des cellules végétales, Linnæa, 1842, p. 278. Translated in Ann. Sci. Nat. Bot. II, XIX (1843), 86.

[44] Observations sur certaines excroissances que presentant les racines d. l'aune et d. lupin des jardin. Ann. d. Sci. Nat. Bot. V. VII, 73. See also footnote 28.

[45] Zu dem Aufsatze des Herrn Prof. B. Frank über Parasiten in den Wurzelanschwellungen der Papilionaceen. Bot. Zeit. 1879. p. 537.

[46] Ueber die Knœllchen an den Leguminosenwurzeln. Ber. d. Deutsch. Bot. Gsells. III (1885). 241-257.

in the tubercles of lupines. He as well as Eriksson[47] showed that two types of structure existed, one represented by the tubercles on lupine, and the other by those on peas, etc.

Schindler,[48] Tschirch,[49] Benecke,[50] Van Tieghem and Duliot,[51] and Sorauer[52] supported Brunchorst's view. Tschirch even went farther and considered the fungus hyphæ to represent nothing but preliminary stages in the differentiation of the cell plasma into bacteroids. Lecomte[53] considered that both the hyphæ and bacteroids were receptacles for the storage of albuminous material. Tschirch[54] calls the tissue in which the bacteroids are found "bacteroid tissue."

B. Frank[55] now unreservedly abandons his earlier views of the parasitic origin of the tubercles and holds it proved by Brunchorst that they represent peculiar organs of the Leguminosæ for the storage of proteid substance. He ascribes to the galls on Alnus, Elæagnus, etc., a similar role, while Brunchorst about this time in a preliminary paper[56] and later in a full presentation of his work on Alnus galls finds them to be due to a fungus.[57]

Thus the question hung, as it were, in the balance at the close of what might be termed the middle period of investigations on this subject. But important contributions were soon to be published which would remove all doubt of the causal relationship of the soil organisms to the tubercles.

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[47] Studier œfver Leguminosernas rotknœlar. Lund. 1874. Bot. Zeit. xxxv (1874). 381.

[48] Ueber die biologische Bedeutung der Wurzelknœllchen bei den Papilionaceen. Jour. Landw. xxxiii (1885).

[49] Ueber die Wurzelknœllchen der Leguminosen. Gesells. Naturw. Freunde zu Berlin, and Bot. Centralb. xxxi (1887.)

[50] Ueber die Knœllchen an den Leguminosen-Wurzeln. Bot. Centralb. xxix (1887). 53.

[51] Origine, structure et nature morphologique des tubercles radicaux des Légumineuses. Bull. d. Soc. Bot. France. xxxv (1888).

[52] Zusammenstellung der neuern Arbeiten über die Wurzelknællchen und deren als Bakterien angesprochene Inhaltskœrperchen, Bot. Centralb. xxxi (1887). 308.

[53] Bulletin d. l. Soc. Bot. d. France. 1888.

[54] Beitræge zur Kenntniss der Wurzelknollchen der Leguminosen. Ber. d. Deutsch. Bot. Gesells. v (1887). 58.

[55] Sind die Wurzelanschwellungen der Erlen und Elæagnaceen Pilzgallen? Ber. d. Deutsch. Bot. Gesells. v (1887).

[56] Ueber die Knœllchen an den Wurzeln von Alnus und den Elæagnaceen. Bot. Centralb. (1880). 354.

[57] Ueber einige Wurzelanschwellungen, besonders diejenigen von Alnus und den Elæagnaceen. Unters. Bot. Inst. Tübingen. ii (1886). 151.

Recent period of investigation.

Ward[58] by a very careful series of inoculations with soil material proves conclusively that the tubercles are caused by some organism which is very abundant in the soil. Frank[59] had even earlier carried out similar experiments which pointed to like results. Ward traces the development of the fungus strands from infection in the root hairs, its growth down into the cortical parenchyma, and into the tissue of the tubercle, where it branches in all directions. He describes and figures the peculiar enlargements where the hyphæ pass through the cell walls, and also enlarged portions of the hyphæ within the cell lumen, characters which we have seen were noted by earlier observers.

On some of these enlarged portions he observed very small buds, or "gemmules," as he termed them, similar to those described by Frank. He considers these the points of origin of the bacteroids, in fact that the bacteroids, or gemmules, are budded off from the hyphæ. According to Ward these gemmules then increased by farther budding within the tubercle. Since there was some correspondence between this supposed development of the gemmules, or bacteroids, with the development of the sporids from the promycelia of some of the Ustilagineæ, and the successive buddings of the sporids in nutrient solutions, as shown by Brefeld,[60] Ward[61] believed the fungus of the tubercles to be related to the Ustilagineæ, but through its peculiar symbiotism with its host, by which the "gemmules" could be preserved through the summer period and then during winter and spring set free by the decay of the tubercles, there was not the need of resting spores such as are found in the known Ustilagineæ, and consequently they had ceased to be produced. About the same time the cultural researches of Hellriegel,[62] Hellriegel

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[58]On the tubercular swellings on the roots of Vicia Faba. Phil. Trans. Royal Society. CLXXVIII (1887). 139–562.

[59]Bot. Zeitung, XXXVII. n. 24–25, 1879.

[60]Botanische Untersuchungen. v. Die Brandpilze I. 1883.

[61]See also, On the tubercles on the roots of leguminous plants with special reference to the pea and bean. Proceed. Royal Society. XLVI. 1889.

[62]Welche Stickstoffquellen stehen den Pflanzen zu Gebote? Tageblatt d. Naturf. Versamml. zu Berlin, 1886, p. 290.

and Wilfarth,[63] and Laws and Gilbert[64] confirmed the investigations of Ward, that the tubercles are due to the action of some organism within the soil.

Ward pointed out that the relation of the low organism to its host was that of a symbiosis, with mutual benefit. Lundstrœm[65] entertains similar views, but left it undetermined whether the lower symbiont was a plasmodium or one of tne bacteria.

In 1888 a very important contribution to the biology of the organism was presented by Beyerinck.[66] He undertook the cultivation of the organism in artificial media and claims to have carefully studied the development and morphology of several races or varieties, and in the tubercles he thought he could trace the development of the bacteroids from bacteria. The organism he considers one of the bacteria, and names it *Bacillus radicicola*. Besides the rod forms he describes a motile form of the organism which is very much smaller. He rejected the idea of the presence of fungus hyphæ. These he considered to be the products of nuclear division. Not admitting a hypha as the means of infection he tried to explain the entrance of the organism and its passage from cell to cell by stating that there were invisible pores in the cell walls.

In 1888 Vuillemin[67] published his investigations, the results of which, while maintaining the relation of some symbiont in the tubercles, appear to be quite at variance with others concerning the nature of the organism. His studies of the development of the organism were directed to an examination of certain of the tubercles in the autumn. He observes the fungus threads and interprets the enlargements as sporangia. He claims to have observed the formation of zoospores in the sporangia. These he describes as pyriform, with a cilium at

[63] Untersuchungen über die Stickstoffnahrung der Gramineen und Leguminosen. Beilageheft z. d. Zeitschr. f. d. Rübenzucker Ind. d. D. R. Berlin, Nov. 1888. Review in Bot. Centralb. XXXIX (1889). 138.

[64] On the present question of the sources of the nitrogen of vegetation, etc. Phil. Trans. Royal Society, CLXXX. B. 1–107. Etat actuel de la question des sources d'azote de la vegetation. Ann. Agr. XIV (1888).

[65] Ueber symbiotische Bildungen bei den Pflanzen. Bot. Centralb. XXVIII (1886).

[66] Die Papilionaceenknœllchen, Bot. Zeit. 1888, p. 725–735, 741–750, 757–771, 780–790, 797–804.

[67] Les tubercles radicaux des Léguminenses, Ann. d. Sci. Agr. Franç. et Etrang. 1888, p. 96.

the smaller end. They conjugate by fusion and form cysts. The non-septate character of the hyphæ taken in conjunction with the formation of zoospores, would ally the fungus with the *Chytridiaceæ* and Vuillemin considered it to be an undescribed species of the genus *Cladochytrium*, and called it *Cl. tuberculorum*. A comparison with Nowakowski's description and figures of *Cladochytrium tenue*[68] shows at least a striking resemblance in the form of the fungus as the hyphæ ramify through the tissues of *Acorus*, presenting here and there intercalary and terminal sporangia.

Vuillemin, with Ward,[69] Lundstrom[70] and Schindler,[71] believes a symbiosis to exist between the fungus and the Leguminosæ. While Lundstrœm classes the tubercles in the category of organs which are the products of mutual association, called by him "domatien,"[72] Vuillemin[73] prefers the name suggested by Frank[74] and calls them "*Mycorhizes endotrophiques*," or "*endomycorhizes*." Ward[75] shows that their inclusion among the Mycorhizæ is as logical as that of Frank's inclusion[76] of Warlich's[77] orchid root fungus.

Frank later[78] distinctly places them, as well as the galls, on Alnus, Elæagnus, etc., among his Mycorhizæ.

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[68] Beitrag zur Kenntniss der Chytridiaceen, In Beiträge zur Biologie der Pflanzen, II (1876). 73-121.

[69] Phil. Trans. Royal Society, CLXXVIII (1887). 539–562.

[70] Ueber symbiotische Bildungen bei den Pflanzen, Bot. Centralb. XXVIII (1886).

[71] Zur Kenntniss der Wurzelknœllchen der Papilionaceen, Bot. Centralb. XVIII (1884). 86.

[72] Ueber Mycodomatien in den Wurzeln der Papilionaceen, Bot. Centralb. XXXIII, 1888.

[73] Remarques sur le memoire de Lundstrœm. Jour. de Botanique, April, 1888.

[74] Ueber die auf Wurzelsymbiose beruhende Ernährung gewisser Bäume durch unterirdische Pilze. Ber. d. deutsch. bot. Gesells. III (1885). 128–144. Neue Mittheihungen über die Mykorhiza der Bäume und der Monotropa hypopitys. Ber. d. deutsch. bot. Gesells. III (1885).

[75] Some recent publications bearing on the question of the sources of nitrogen in plants. Annals of Botany, I. (1887–1888). 325–357.

[76] Ueber neue Mykorhiza-Formen, Ber. d. deutsch. bot. Gesells. V (1887). 395–408.

[77] Beitrag zur Kenntniss der Orchideenwurzelpilze. Bot. Zeitung. XLIV. (1886).

[78] Ueber die auf Verdauung von Pilzen abzielende Symbiose der mit endotrophen Mykorhizen begabten Pflanzen, sowie der Leguminosen und Erlen. Ber. d. deutsch. bot. Gesells. IX (1891). 244-253.

Following close upon Vuillemin's contribution were several by A. Prazmowski, a preliminary paper in 1888,[79] in which he considers the tubercles to be due to a parasitic fungus related to Woronin's *Plasmodiophora brassicæ*.

A second paper appeared in 1889,[80] and the final results of his study of the etiology and development of the tubercles was published in 1890.[81] Prazmowski now believes the tubercles to be due to one of the bacteria and he describes the organism obtained by himself in artficial cultures from the tubercles. By inoculation with the same he succeeded in developing the tubercles. According to him it is a bacterium. In artificial cultures it always develops in the form of simple short rods, which may for a time remain joined in short chains, but it never forms filaments. The rods may farther divide up into short cells, and it possesses a motile form. He denies the presence of fungus hyphæ, regarding them as gelatinous tubes which the organisms excrete to form a protective covering for the mass. The manner of infection through the root hairs agrees in all essential respects with that described by Ward (l. c.), only Prozmowski does not look upon the tube as having any genetic connection with the organism, but simply encloses them while the colony of bacteria directed by a common purpose move along together with the advancing tube down into the tissue of the root. In regard to this unity of purpose exhibited by the colony as described by Prazmowski, his organism would show a relationship to Thaxter's *Myxobacteriaceæ*.[82]

Prazmowski was unable to demonstrate the membranous nature of the tube, while there seems to be pretty good evidence from the experience of Eriksson,[83] Ward,[84] Vuille-

[79] Ueber Wurzelknœllchen der Leguminosen, Bot. Centralb. XXXVI (1886). 215–219, 248–255, 280–285.

[80] O istocie i znaczeniu korzeniowych grochu. Berichte aus d. Sitz. d. k. k. Akad. d. Wissensch. in Krakau, June, 1889. Das Wesen und die biologische Bedeutung der Wurzelknollchen der Erbse. Bot. Centralb. XXXIX (1889). 356–362.

[81] Die Wurzelknollchen der Erbse; Erster Theil, Die Ætiologie und Entwicklungsgeschichte der Knollchen. Landw. Versuchs-Statlonen. XXXVII (1890). 160–236.

[82] On the Myxobacteriaceæ, a new order of Schizomycetes. Bot. Gazette, XVII (1892). 12.

[83] Studier œfver Leguminosernas rotknœlar. Lund. 1874. Bot. Zeit. XXXV. (1874). 381.

[84] Phil. Trans. Royal Society. CLXXVIII. (1887). 539–562. Proceed. Royal Soc. XLVI (1889). 431–443.

min,[85] Pichi,[86] A. Koch,[87] and Laurent[88] that a membrane does exist.

Short communications by Delpino[89] and Mattei[90] about this time support the view that the tubercles are caused by bacteria.

In 1890[91] Frank appears with still another contribution. While he does not wholly return to his earlier convictions he retraces his steps far enough to once more champion the causal relation of some soil organism. This time he believes the organism to be micrococcoid and names it *Rhizobium leguminosarum.* He still recognizes the two form elements in the tubercles, the hypha-like strands and the bacteroids. The former he believes to be a homogeneous mixture of the cell protoplasm of the two symbionts, in which nothing is visible indicative of the nature of the *Rhizobium* or the protoplasm of the leguminous plant. This mixture he terms *mycoplasm.* Upon treatment with certain reagents the portion of the mycoplasm belonging to the host plant dissolves and sets the micrococci free. Frank also obtained his *Rhizobium* in artificial culture and produced the tubercles by inoculation with the same. The bacteroids he regarded as fragments of the mycoplasm, while in a more recent communication[92] he says they are hypertrophied forms of the *Rhizobium.*

In the same year Laurent published a preliminary paper[93] on this subject, followed in 1891[94] by a more complete exposition of his investigations. He also obtained the organism in artificial cultures and recognizes the genetic connection of the bacteroids and fungus strands, believing with Ward and the earlier tenets of Frank that the bacteroids are budded off

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[85] Ann. d. Sci. Agr. Franç. et etrang. 1888. p. 96.

[86] Alcune osservazioni sui tubercoli radicali delle Leguminose. Atti della Società Toscani di science naturali. 1888.

[87] Zur Kenntniss der Fäden in den Wurzelknöllchen der Leguminoseen.

[88] Ann. d. l'Institut Pasteur. v. (1891). 105–139.

[89] Osservazioni sopra batteriocecidii e la sorgente l'azote in una piante Galega officinalis. Malpig. II. fasc. 9–10. (1889). Cited by Prazmowski.

[90] Ancora sull' origine della Vicia faba. Bologna. 1887. Cited by Vuillemin.

[91] Ueber die Pilzsymbiose der Leguminoseen. Berlin, 1890.

[92] Berichte d. deutsch. bot. Gesellsch. IX. (1891). 244–253.

[93] Sur le microbe des nodosités des Légumineuses. Compt. Rend d. Sc. Paris. 1890. pp. 754–756.

[94] Recherches sur les nodosités radicales. Ann. d. l'Inst. Pasteur. v. (1891). 105–139.

from the hyphæ. He treats of the organism as a yeast form, and while in his artificial cultures a large number of the individuals were rod-like, some presented an irregularly lobed form. These forms together with the development of the bacteroids from the hyphæ he judges separates the organism from the true *Schizomycetæ*. He accepts Frank's name *Rhizobium leguminosarum*, but believing it to be related to Metschnikoff's *Pasteuria ramosa*,[95] he locates it in the *Pasteuriaceæ*.

During the last year an article on this subject has appeared from an American writer.[96] The original part of Schneider's paper deals with the morphology of the bacteroids of several leguminous species, the variations in form of the bacteroids alone seeming in the estimation of the author sufficient ground for the characterization of species, and several species and varieties are named. Schneider accepts Frank's generic name *Rhizobium*, but rejects his theory of a mycoplasm. He denies the genetic connection of the bacteroids with the hyphæ, and definitely rejects the idea of any causal relation of the fungus hyphæ to the tubercles. He observes fungus threads in the tubercles, but cannot differentiate them from fungus threads which he finds in other parts of the roots where there are no tubercles.

[*To be concluded.*]

Cornell University.

BRIEFER ARTICLES.

Two new plants from Washington.—Allium Hendersoni.—About a foot high: bulb white, ovate, 6–7 lines in diameter, finely but indistinctly reticulated: leaves 2, linear-oblong, attenuate, thickish, 4–6 inches long, as many lines broad: scape rather stout, much exceeding the leaves: umbels many-flowered, globose: spathe 3-parted; bracts ovate, acuminate, 6–8 lines in length: pedicels 8–10 lines long: segments of the perianth rhombic-ovate, acuminate, 3–4 lines long, purple, with light midrib: stamens exserted: ovary 6-crested: seeds dull black, compressed, obovate, 1½ lines in length.—Collected near Pull-

[95] Pasteuria ramosa, un représentant des bactéries a division longitudinale. Ann. d. l'Inst. Pasteur. II. (1888.) 165–170.

[96] Observations on some American Rhizobia. Bull. Torrey Bot. Club XIX. July, 1892.

man, Washington, June, 1892, by Prof. Louis F. Henderson, (n. 2,482) and in a neighboring locality and same month by Mr. W. R. Hull (n. 621).

Near *A. Lemmoni* Wats. but differing in the relatively much shorter and broader leaves, much more numerous flowers, distinctly exserted stamens and 3-parted spathe; differing from *A. platycaule* Wats. in its taller scape, shorter and broader perianth segments and crested ovary.

Calochortus ciliatus.—Low, 6–8 inches in height, branched above: bulb ovate, ½ an inch in diameter: leaf solitary, 2½–3 lines broad, equalling the 4–8-flowered stem: bracts linear, attenuate: flowers rather small: sepals ovate, acuminate, greenish-white, scarious-margined, 4–6 lines long: petals of equal length, light bluish-purple, paler towards the edges, triangular-lanceolate, rather abruptly narrowed at the base, conspicuously ciliate, glabrous except the yellow doubly fringed lunate scale of the gland: stamens half as long as the petals: anthers oblong, sagittate, apiculate, 2–2½ lines in length: capsule elliptical in outline, acutely 3-winged, 7–8 lines long.—Collected by T. S. Brandegee, Wenatchie Region, Washington, July, 1883 (n. 1,107), and by Prof. L. F. Henderson on grassy slopes among pines, upper Nachez river, Yakima co., Washington, June, 1892 (n. 2,485).—B. L. Robinson and H. E. Seaton, *Gray Herbarium, Cambridge, Mass.*

EDITORIAL.

There is an extraordinary diversity of usage in the matter of citation of references, much more than would be imagined by those who have not directed their attention to it. Writers who would be unsparing in their condemnation of carelessness in observation or experiment are strikingly careless in their citation of the work of others. Some papers on the contrary which have less value in themselves are characterized by such complete and accurate bibliography that they become valuable in spite of their scanty additions to knowledge.

It seems to us that the cardinal rule that should govern citations is that papers should be so cited that they can be found with the least possible expenditure of time and trouble by one who wishes to consult them. What information is indespensable will vary with the nature of the publication. For instance the citation "Bot. Gaz. 1890. 132" would enable one to find a given paper; but the citation "Bot. Centralb. 1890. 132" would not, since there are four pages bearing that number in the four volumes for 1890. If it were so cited the seeker might have to examine all of these before finding the one desired.

But even "Bot. Gaz. 1890. 132" is not adequate to the most ready finding of the reference. In binding such journals many libraries indicate on the back only the number of the volume. If the year only were cited two volumes or more might have to be taken down, whereas if the citation "Bot. Gaz. XVI (1890). 132" the paper could be found with the greatest ease, since no data are lacking.

In our opinion the following items should be given in a full citation: (1) the title of the article; (2) the name of the publication, if abbreviated at all abbreviated so as to be readily identified ("Jour. Bot." would not be so); (3) series number, if any; (4) volume number; (5) year; (6) page. Designating the part, heft, lieferung or fascicle is generally useless.

For the sake of greater uniformity of typography the GAZETTE has tentatively adopted that shown in the following samples. It would be a convenience if authors would follow this plan, or would agree upon some other in this time of botanical agreements.

VAN TIEGHEM et DOULIOT: Les racines des phanérogames. Ann. Sci. Nat. Bot. VII. VIII. (1891). 256.

VAN TIEGHEM: Traité de Bot. II. 398. Paris. 1891.

CURRENT LITERATURE.

Sachs' Writings on Vegetable Physiology.

In the domain of vegetable physiology there is one name that stands high above all others. It is that of Dr. Julius von Sachs, the eminent professor of botany in the University of Würzburg. He is not the father of the science, that honor belonging to Stephen Hales, an Englishman of a century ago, but he is its deliverer, having rescued it from an inconsequential condition, in which it received slight consideration, and by his rare insight and acute experimentation, his breadth of view and solidity of judgment, and especially by his ability in coördination, having placed it among the foremost of the several divisions of the science of botany. At the time he began to write more physiological work was done by chemists and physicists than by botanists, and the subject was not taught as a separate study; now laboratories and chairs are often exclusively devoted to it, and it has risen to equal dignity with the other departments of botany.

The writings of Dr. Sachs, which are the basis of this advancement, and to which every investigator must refer who desires to examine the original publication of facts discovered during the last thirty-five

years, are scattered through many journals and proceedings of societies, as is the case with the writings of most authors, and it was an act of special consideration for the learned author to devote some of the time of his declining years to the collection and editing of the most important of his writings. The result we now have in a heavy volume[1] of over twelve hundred pages. The publisher has issued it in two parts (erroneously called volumes on the title page), with continuous paging and single index. Forty-three memoirs are included, the principle of selection being to take those which deal most fully with observation; for while theories and explanations are subject to continued variation, true facts remain immutable. The original publication of the articles dated from 1859 to 1892. In the collected form the chronological arrangement is not closely adhered to, but a certain sequence of topics is maintained under the following headings: physical and chemical phenomena of vegetation, growth, formation of cells and irritability. Unimportant parts of the original articles have been omitted, but no additions have been made, except when an explanation seemed to be needed to show the connection with the present state of knowledge, and such additions are always distinctly indicated.

These memoirs supplement and substantiate the author's text books. It is impossible to more fully outline here the interesting contents of this large volume, and it must suffice to say, what is but simple fact, that it will prove indispensable to the student of vegetable physiology, not only on account of the invaluable memoirs it contains, but because of the convenient form in which they are presented.

Minor Notices.

THE SECOND VOLUME of Massee's British Fungus-Flora[2] is now issued, and is an exact counterpart of the first volume, noticed in the January issue of this journal (p. 31). A few more species are included, than in the first volume, making nearly 1,600 species in both. The present volume does not yet carry the work through the Basidiomycetes. As the work is to be completed in three volumes, we are at a loss to see how the author can justify his selection of a title. If the third and concluding volume is like the preceding ones, there will yet remain 2,500 species of the "British fungus-flora" unprovided for, if by that term is meant the species of British fungi. That is, in a work

[1] SACHS, JULIUS.—Gesammelte Abhandlungen über Pflanzen-Physiologie. pp. x. 1,243. pl. 10, figs. in text 126. royal 8vo. Leipzig, Wilhelm Engelmann, 1892-93. Marks 29.

[2] MASSEE, GEORGE.—British fungus-flora: a classified text-book of mycology. 3 vols. Vol. II. pp. 432. Illustrated. 8vo. London, George Bell & Sons, 1892.

which purports to cover the whole field of the British fungous flora, and to be a "classified text-book of mycology," only half of the known species of fungi found in the region are included. However, the author may have some way of avoiding the dilemma.

A VALUABLE monograph upon the American species of Saprolegniaceæ has recently been published by James E. Humphrey.[1] It appears in the Transactions of the American Philosophical Society, but has also been distributed separately. The group was greatly in need of study, and it is gratifying to have the labor so handsomely and so substantially done. The author found little material upon which to begin his work, and with the exception of some aid from a half dozen collectors, chiefly from the material gathered over ten years ago by Dr. William Trelease, he was dependent upon his own collections made during the two years given to the study. Considerable space is devoted to the morphology of the group. Under the head of classification twenty-one species are described, belonging to seven genera. These include six new species, while the study of European forms not yet found in America has led to the separation of a new genus, and the change of name of two species. The seven lithographic plates are particularly fine, and will be a great help in future study. This work will undoubtedly give a decided impetus to the study of these more than usually interesting aquatic fungi. An extensive bibliography completes the paper.

A BIBLIOGRAPHY of the tannoids covering 27 pages and including over 450 entries has been prepared by J. Christian Bay, and distributed as a reprint issued in advance of the fifth annual report of the Missouri Botanic Garden. The author published a bibliography of inulin recently, and proposes to follow with other subjects. Such works are of the greatest value to investigators, and their preparation should receive the utmost encouragement from every botanist.

THE ARTICLE UPON BOTANY in pharmacy by John S. Wright in a recent number of *Science* has been reprinted with additional illustrations and distributed by Eli Lilly & Co. in the form of a neat pamphlet.

[1] HUMPHREY, J. E.—The Saprolegniaceæ of the United States, with notes on other species. From Trans. Amer. Phil. Soc., XVII. pp. 63–148. pl. XIV–XX. 4to.

OPEN LETTERS.

A misunderstanding corrected.

Some time ago I was informed by a friend that Prof. Conway MacMillan in the introduction to his "Metaspermæ of the Minnesota Valley," had credited me with holding some remarkable views on the subject of botanical nomenclature that certainly had never occurred to my mind. I had some difficulty in consulting the book in question, as copies of it do not seem to be abundant in this part of the country, but finally succeeded in borrowing a copy for a somewhat hasty examination. I then found to my surprise that the author had cited me as an authority for the proposition that botanical nomenclature should be passed upon by a non-scientific commission, and referred to a communication of mine printed in the GAZETTE, XVI, 4, to support his statement. I am very sorry that any one could have so misunderstood my meaning, for my plea was for nothing of the kind. It was only for more intelligent appreciation of actual, practical needs, and present difficulties, and for more judicial and fair-minded consideration and less partisanship. I have faith enough to believe that there are in this country, as there certainly are in other countries, able botanists who are also men of affairs and men of sound judgment, men who can look beyond the walls of the herbarium and can realize that a theory should be subordinated to practical necessities. When the supply of such botanists fails us, it may then be time to consider the expediency of referring the question of botanical nomenclature to a non-scientific commission; but until then I should not wish to advocate such a treatment of the question even if I were as unthinking and unbotanical as Prof. MacMillan appears to consider me. Although men of intelligence and of practical acquaintance with the general laws of nomenclature are undoubtedly competent to pass on the nomenclature of a science to a certain extent, yet no one would claim for them alone the right to absolute and final decision of its problems.

While I consider that Prof. MacMillan's book reflects great credit on his industry and genius for compilation, yet, as a model local flora, it seems to me a number of steps in the wrong direction, especially in this case where, as the author himself states, the work is addressed to the people. As the book stands, an abridged or expurgated edition really appears to be a necessity if the volume is intended for popular use. I cannot, moreover, help regretting that the learned author has laid his work open in so many ways to the knife of an impartial critic, not to mention the assaults of an opponent. In such respects the book shows more partisan than judicial spirit—a failing much to be deplored in a work presumably printed at the public expense, and from which the public consequently has a right to demand a fair and impartial statement of disputed questions.—EDWARD L. RAND, *Boston.*

NOTES AND NEWS.

TWENTY-ONE new species of Canadian parasitic fungi are described by J. B. Ellis and J. Dearness in the *Canadian Record of Science* for January.

DR. W. JANNICKE, lecturer on botany in the Senckenberg Institute at Frankfort on the Main, died the latter part of March. Dr. Möbius of Heidelburg has been elected to the position thus made vacant.

THE MARINE BIOLOGICAL LABORATORY at Wood's Holl, Mass., opens its sixth season on June 1st. The botanical laboratory for teachers and students will open July 5th, in charge of Dr. W. A. Setchell, instructor in botany, Yale University, and W. J. V. Osterhout, of Brown University.

M. MAURICE GOMONT publishes in the *Annales des Sci. Naturelles* VII. XVI. 91–256 the second part of his Monograph of the Oscillarieæ, including the second tribe, the Lyngbyeæ. The work seems to bethoroughly done, the full citation of synonymy (which is copious) and the keys to the genera and species being especially serviceable.

THE FIRST SESSION of the Hopkins Seaside Laboratory, of the Leland Stanford University, held during last summer, was a very successful one both in the attendance and in the results accomplished. The great advantages which is was thought the location selected would afford more than met the most ardent expectations when brought to the actual trial. The course of instruction for the session of 1893 will open June 5th and close July 15th, though investigators and advanced students may arrange to continue their work for a longer period. The coming session will open with a better equipment, improvement in the buildings and the more intimate knowledge of the collecting grounds resulting from a year's experience in the locality. The building provided is a plain two-story frame structure, 60×20 feet, located on a low bluff immediately overlooking the beach at Pacific Grove near Monterey, where the variety and abundance of marine life is exceptionally great.

AMONG THE station bulletins received in the last month the following are of botanical interest. "Canaigre" (Rumex hymenosepalus) by Collingwood, Toumey and Gulley (Ariz., no. 7) has its economic value as a source of tanning material. The history, botanical and chemical characteristics, and cultivation are fully treated. "Conditions affecting the value of wheat for seed" and "Prevention of potato scab" by H. L. Bolley (N. D., no. 9) form an interesting bulletin of 41 pages. The first subject deals with the injury to seed grain caused by freezing, over-heating, immaturity, etc., and the second with the corrosive sublimate and other methods of controlling potato scab. "Preliminary report on rusts of grain" by A. S. Hitchcock and M. A. Carleton (Kans., no. 38) is chiefly devoted to the effect of various chemicals upon the germination of uredospores. "Some diseases of cotton" by Geo. F. Atkinson (Ala., no. 41) is quite an exhaustive treatise of 65 pages. "Some celery diseases" (N. Y., no. 51) is a good account of this subject. Although no author is mentioned it is probably to be credited to S. A. Beach. All the above papers are amply illustrated.

THE JOURNAL of the Quekett Microscopical Club, a quarterly publication, is issued under the editorship of Edward M. Nelson since the death of Henry F. Hailes, which occurred last October. Mr. Hailes had been the editor for nine years.

DR. F. PAX, who was formerly connected with the Botanic Garden of Breslau, but more recently custodian of the Botanic Garden of Berlin, has been tendered the position of Professor of Botany in the University of Breslau and Director of the Botanic Garden to succeed Dr. Prantl, deceased.

A LONG LIST of new species of fungi is given by J. B. Ellis and B. M. Everhart in the Proceedings of the Philadelphia Academy of Sciences, under date of Feb. 28th, being pages 128 to 172. It is also issued separately. There are described 53 Pyrenomycetes, 24 Discomycetes, 11 Uredineæ, 2 Ustilagineæ, 46 Sphæropsideæ, and 13 Hyphomycetes, making a total of 149 species.

THE SUMMER COURSES of instruction in the Cornell University begin July 6th and continue to August 16th. The botany is under the charge of Mr. W. W. Rowlee. Four courses are offered: 1, general course; 2, systematic work, especially with composites and grasses; 3, histology; and 4, study of cryptogams. The fee is $20 for one course, or $30 for two, with the cost of laboratory material added.

The tenth annual report of the Massachusetts state experiment station for 1892 contains the report of J. E. Humphrey (pp. 211–247), dealing with plant diseases. It includes several diseases of cucumber, a violet Phyllosticta, black knot of plum, grain rusts, and various mildews. The account of Sclerotinia Libertiana on cucumber is especially interesting. Five excellent plates accompany the report.

THE INDIANA ACADEMY of Science held its annual spring field-meeting at Terre Haute, May 17th and 18th. The plans for a complete biological survey of the state were perfected, and their execution entrusted to a board ot directors, consisting of three members to represent the departments of zoology, botany and paleontology. The first report will be made at the winter meeting, next December. Prof. L. M. Underwood of De Pauw University was chosen director in charge of botany.

THE ANNUAL REPORT for 1892 of the Connecticut experiment station contains the report (pp. 36–49) of the mycologist, W. C. Sturgis, devoted largely to treatment of plant diseases. Spraying of potatoes and quinces with copper compounds, and the prevention of injury to asters and other plants by nematodes are the chief topics. The report for 1892 of the Storrs experiment station of Connecticut contains an account (pp. 17–22) of experiments upon the fixation of free nitrogen by plants, peas being used, conducted by W. O. Atwater and Chas. D. Woods. It also contains the fourth report of H. W. Conn upon bacteria in milk (pp. 106–126), giving the course of experiments which resulted in the separation of an enzyme from several species of milk bacteria, that possesses the same physiological action as animal rennet.

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